SCIENTIFIC AMERICAN SUPPLEMENT. No. 1180

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Scientific American, established 1845.
Scientific American Supplement, Vol. XLVI, No. 1180. NEW YORK, AUGUST 13, 1898. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

A GENERAL DESCRIPTION OF THE WHITEHEAD TORPEDO.

By W. J. Sears, Lieutenant, United States Navy.

THE Whitehead torpedo is built chiefly of steel, and is nearly in the shape of a porpoise. It has a blunt, phosphor-bronze head, and is made in five sections, but dismounted and assembled in four principal parts: the head, air flask and immersion chamber, after body, and tail, all fitted together with sleeve joints, and held together by joint screws. The motive power of the torpedo is compressed air. It is propelled by two two-bladed screws, revolving about the same axis in opposite directions, in order to neutralize their individual tendencies to cause the torpedo to roll. The after propeller is keyed to the main shaft, and the forward propeller to a sleeve or hollow shaft, free to move on the main shaft. By means of bevel gears on the main shaft and on the forward end of the sleeve, suitably arranged, the propellers revolve in opposite directions.

Its principal dimensions are:

Weight of torpedo, ready for discharge (about)	1,160 lb.
Weight of wet guncotton (approximately)	220 lb.
Length of torpedo (5 meters)	16 ft. 5 in.
Greatest diameter (45 centimeters)	17·7 in.
Speed (about)	28 knots
Range (at 28 knots speed) about	850 yds.
Capacity of air flask	9·9 cu. ft.
Weight of air charge (at 62° F. and 1,350 lb. pressure per square inch)	69·19 lb.
Reserve buoyancy in sea water, specific gravity 1.026, at 62° F., about	½ lb.
Weight of Obry gear	8 lb. 6 oz.

The torpedo is maintained at constant depth by horizontal rudders, and on a straight course by vertical vanes set at an angle predetermined by experiment, or by movable vertical rudders controlled by the Obry gear. These torpedoes are a decided improvement, in the matter of speed and certainty of work, on the earlier type of shorter torpedoes. The war head, of sheet phosphor-bronze, is charged with approximately 220 lb. of wet guncotton, and is closed at its base by a bronze bulkhead. In the bulkhead is a moisture tap, through which distilled water may be poured when necessary to make up possible loss of weight by evaporation. Soldered in the forward end of the war head is the primer case, of brass, in which is inserted the dry cotton primer. The wet guncotton is inserted in a series of disks, a sufficient number of them, counting from forward, being pierced through their centers to receive the primer. The primer consists of a series of small cylinders of dry guncotton in a metal case. The forward cylinder is pierced to receive the detonating primer, containing fulminate of mercury, and capped with a percussion cap. The exercise head, of steel, is ballasted for exercise by filling it with fresh water. The war nose screws into the forward end of the primer case. A traveling sleeve has a thread cut inside, throughout its length, and in this thread works a traveling nut. This nut is turned by a screw fan, receiving its motion by its passage through the water. The nut is screwed back by the action of the

FIG. 1.—FIVE-METER (U. S. MARK I.) WHITEHEAD TORPEDO.

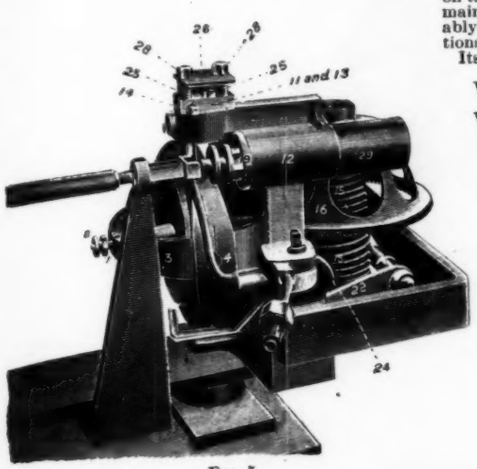

FIG. 5.

FIG. 6.

OBRY GEAR ON ADJUSTING STAND.

LIST OF PARTS.

1. Gyroscope wheel. 2. Male centers. 3. Inner ring. 4. Outer ring. 5. Locking screws. 6. After centering screw. 7. Nut. 8. Jamb nut. 7 and 8. Counterbalance. 9. Pin for valve arm. 10. Valve arm. 11. Rolling valve. 12. Steering engine. 13. Valve plug. 14. Adjusting screws. 15. Impulse spring. 16. Impulse sector. 17. Adjusting stand. 18. Holding-down screws. 19. Cylinder head. 20. Clutch. 21. Vertical rock-shaft. 22. Horizontal rock-shaft. 23. Double-acting rock-shaft spring. 24. Auxiliary rock-shaft spring. 25. Holding-down springs. 26. Holding-down plate. 27. Holding-down studs. 28. Holding-down nuts. 29. Air-cushion cylinder. 30. Impulse sector stop. 31. Socket for winding key.

FIG. 7.

OBRY GEAR—GYROSCOPE WHEEL, RINGS, IMPULSE SECTOR SPRING, AND ROLLING VALVE DISMOUNTED.

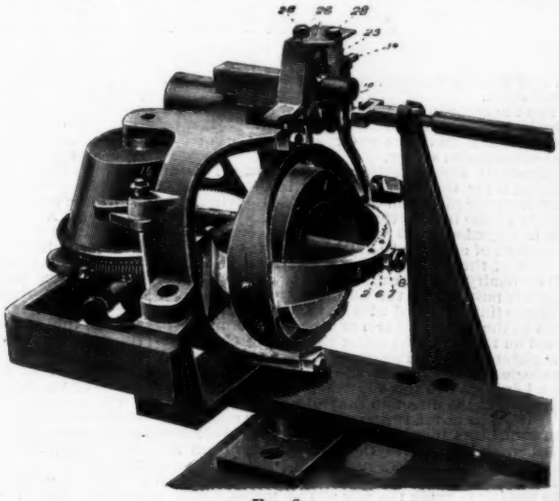

FIG. 8.

OBRY GEAR ON ADJUSTING STAND.

fan until it rests against the firing pin. A shearing pin holds the latter in place, and as the nut continues to revolve the sleeve moves out, carrying the fan with it, until the square shaft of the fan is pushed out clear of the nut. The fan then revolves freely. When the torpedo strikes the target, the fan, nut, and sleeve are driven in, shearing the shearing pin and driving the firing pin against the percussion cap.

The air flask is a hollow, forged steel cylinder, slightly tapered at the ends, with dome-shaped heads screwed and soldered in each end. A strengthening band, left on the inside surface in boring, is tapped from the outside for three screws for attaching the guide stud. Over a hole in the after head is bolted and soldered the body of the charging and stop valves.

Immersion Chamber.—This chamber contains the immersion regulators. It is just abaft the air flask, and is riveted and soldered to it. The after end is closed by a bronze bulkhead.

The purpose of the mechanism in this chamber is to control the horizontal rudders after launching, so as to bring the torpedo to a predetermined immersion, and keep it there during the flight. This is accomplished as follows:

A small compartment in rear of the immersion chamber has free communication with the water outside through several apertures in its walls. The pressure of the water, due to depth below the surface, acts against a piston, but the water is prevented from getting behind the piston by a circular diaphragm of thin rubber. The motion of this piston, due to different pressures at varying depths, is communicated to the horizontal rudders by means of rods in such a manner that when the torpedo is below its plane of immersion the increased pressure will elevate the rudders, and when it is above, the decreased pressure will depress them.

When the torpedo is in its plane of immersion, the piston is kept in mid-position by an equilibrium between the pressure of the water and the tension of a spiral compression spring.

Hydrostatic Piston-Testing Attachment.—This attachment is for the purpose of testing the action of the hydrostatic piston on the rudder. It obviates the necessity of the bent lever used with the 3·55-meter, Mark I., torpedoes of 45 centimeters diameter.

It consists of a composition jew's-harp link encircling the tube of the hydrostatic piston spring, and fitted at its extremity with a collar that fits over the end of the socket post, under the adjusting nut. The lower end of the link is fitted with jaws, by which it is attached to the horizontal arm of a small bellcrank lever pivoted on the bulkhead under the tube of the hydrostatic piston spring. The upper arm of the bellcrank is connected to the hydrostatic piston by a ball-and-socket joint. When the adjusting screw is turned by the wrench in the direction that releases the tension of the hydrostatic piston spring, the adjusting nut travels downward, bears upon the jew's-harp link, and through the bellcrank lever forces the hydrostatic piston forward its full travel.

Pendulum.—A pendulum, which swings in a vertical plane passing through the axis of the torpedo, acts to maintain the torpedo in a horizontal plane. If the hydrostatic piston is acting on the rudder to steer the torpedo up or down, when the torpedo has inclined 8° above or below the horizontal plane, the pendulum swings toward the end of the torpedo that is lowest, and counteracts the action of the piston on the rudder. The combined action of the piston and pendulum is transmitted by a system of levers and connecting rods to the steering engine, and thence to the rudder, to maintain the torpedo in the horizontal plane at the set depth.

Engine Room.—Next abaft the immersion chamber comes the after body, containing two compartments; between them is a bulkhead. The joint is made tight by a rubber gasket. To this bulkhead the propelling machinery is secured. The engine room contains the main engine and oil cup, the valve group, the sinking and retarding gear, the steering engine, and the locking gear.

The Whitehead torpedo engine consists of three cylinders, fixed radially about the propeller shaft with their axes 120° apart. Within the circular inclosure, at the junction of the cylinders, the main crank is free to revolve and receives its impulse from the piston of each cylinder in succession. The compressed air is admitted behind the piston and evacuated in proper order by means of three slide valves, each working in a separate chest on the forward face of each cylinder, but all regulated by a single cam, keyed to the main shaft.

The Depth Index.—The depth at which a torpedo runs is adjusted by means of the depth index.

An adjusting screw, with a screw socket in its upper end, is supported at its lower end in a socket post. A nut travels along the thread of the adjusting screw when turned. A fork at one end of the bellcrank presses against a collar on this nut, and a fork at the other end against a compression spring acting against the hydrostatic piston. The lower end of the spindle of the depth index fits in the square socket of the adjusting screw, and has a square socket in its upper end, in which fits a male socket wrench, used in setting the depth index. The spindle carries a worm which gears into a vertical wheel having graduations around a part of its circumference for 5 feet, 10 feet, 15 feet, and 20 feet immersion. A cap screws down over the wormwheel, having a central hole through which the figures may be seen when the wormwheel revolves. A smaller cap screws down (using a square male socket wrench) over the spindle of the index, to keep it in place and to prevent water from entering the immersion chamber.

The desired immersion, in feet, will be obtained by turning the depth-index spindle, with the socket wrench, until the figure indicating this immersion is seen on the wormwheel through the central hole in the cap over the wheel.

The steering engine is operated by air at the working pressure of the main engine, and transmits the action of the immersion mechanism to the rudder.

The combined action of the pendulum and hydrostatic piston is transmitted by a rod to the steering engine valve, which controls the action of the steering engine, and thence the position of the horizontal rudder.

There is no valve star used in this torpedo with the steering engine. One arm of the bellcrank is pivoted to the forward end of the valve stem of the steering engine, the other arm pointing forward. A rod, connecting with the hydrostatic piston and pendulum, is connected with one arm of another bellcrank, the other arm of which points aft, and is pivoted to the elbow of the bellcrank pivoted to the valve stem. A screw (called the valve adjusting screw), with a square head, passes through a collar in the forward end of the after bellcrank, its end screwing in the forward arm of the forward bellcrank. A spring around this screw tends to keep the forward ends of the bellcranks apart. Screwing down on the adjusting screw compresses the spring, brings the two forward arms of the bellcranks closer together, practically lengthens the valve stem, and puts the rudder down. Turning the valve-adjusting screw in the opposite direction shortens the valve stem and puts the rudder up.

The valve-adjusting screw is usually set to give one more division of down rudder than of up rudder, to give plenty of scope of down rudder to steer the torpedo down, as it becomes lighter, on account of the air being used to propel the torpedo. The divisions are marked on the face of a vertical scale which fits, by a collar, over the hollow propeller shaft, and, by a slot, to the upper vertical tail piece. A horizontal pointer is clamped to the rudder and moves over the scale, showing the number of divisions of up or down rudder.

The forward end of the steering rod acts against a spiral spring. When, at the end of the run, air is cut off from the steering engine this spring forces the steering rod forward, puts the rudder up, and brings the torpedo to the surface.

The reducing valve is balanced between the pressure of a spring tending to raise it from its seat and the pressure of air on top of it tending to seat it. The object is to regulate the pressure of air admitted to the engine. A crank is used to screw down a plug which compresses the spring. The number of turns to give this regulator plug for highest speed, for a run of 800 yards, is given on the record sheet of each torpedo.

The starting lever admits air to the reducing valve, from whence it passes to the main engine. Before the torpedo is launched the lever lies flat along the upper surface of the shell, the end pointing forward. When the torpedo is launched the starting lever catches under a tripping latch, in the tube, and is thrown back.

The distance gear provides means for automatically closing the reducing valve, and thus stopping the engines after the torpedo has run a predetermined distance.

In general terms the action of the distance gear may be described as follows: A spindle with a square head is accessible from the outside of the torpedo, through a hole, and may be turned by a socket wrench. The spindle has a worm on its lower end, which engages the teeth of the wheel, with cogs around a portion of its circumference, called a distance sector. One turn of the spindle revolves the sector one tooth, and the number of turns for a run of 800 yards is given on the record sheet of the torpedo.

A small wheel with a sector cut from its circumference, called the friction cam, lies flat along one face of the distance sector. It has a motion of rotation which is limited in one direction by a pin, projecting from its periphery, coming in contact with a stud projecting from the face of the sector. A return spring, connected to the axle of the cam, keeps the pin in contact with the stud in setting the sector, and

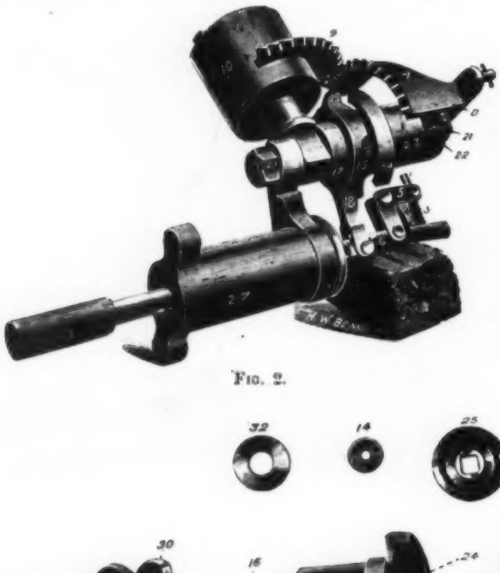

Fig. 2.

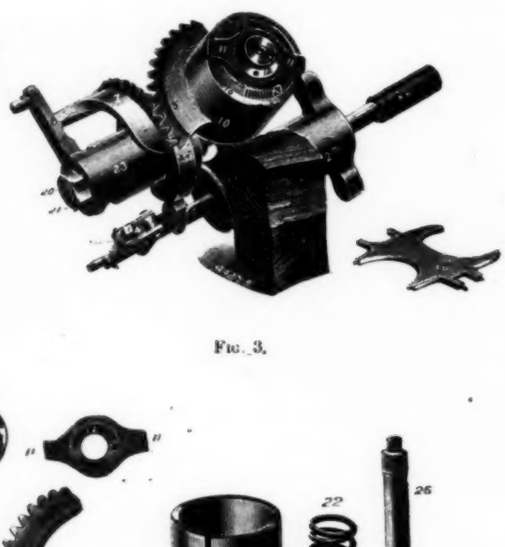

Fig. 3.

Fig. 4.

LOCKING DIAL AND RUDDER INDEX.

List of Parts.

1. Valve adjusting-screw. 2. Valve adjusting screw collar. 3. Valve adjusting-screw spring. 4. Forward bell-crank. 5. After bell-crank. 6. Steering-engine valve-rod. 7. Ratchet-bar sector. 8. Ratchet-bar sector arm. 9. Sleeve-sector. 10. Locking-dial sleeve. 11. Setting-bar. 12. Setting-bar clamp nut. 13. Rudder-index dial. 14. Rudder-index dial clamp nut. 15. Locking-ring. 16. Locking-ring screws. 17. Locking-ring carrier. 18. Long locking-arm. 19. Short locking-arm. 20. Locking-sleeve spindle. 21. Locking-sleeve spindle nuts. 22. Locking-sleeve spring. 23. Locking-sleeve. 24. Locking-flange. 25. Initial-mark dial. 26. Dial spindle. 27. Steering-engine. 28. Circular score in locking-ring carrier. 29. Segmental score in locking-ring carrier (not shown). 30. Rudder-index dial-sleeve cam. 31. Rudder-index dial-sleeve. 32. Locking-sleeve spring washer. 33. Steering-rod union. 34. Locking wrench.

causes the cam to follow the sector in its rotation when the sector is set.

When the torpedo is set in motion the friction cam is revolved against the action of the spring in the opposite direction to that to which it was turned in setting the distance sector, by suitable connections with the main shaft.

When the friction cam has revolved back to the proper position it releases the tension on the spring of the reducing valve, which closes and shuts off the air from the main engine.

Retarding Gear.—The object of this gear is to retard the admission of air to the engine from the instant of launching until the torpedo enters the water, thus preventing undue racing of the engine. A lever, called the retarding lever, is so arranged that when it is in a certain position (its after position) it will allow the reducing valve to open only slightly, thus throttling down the main engine. This lever is operated by a bellcrank lever to which is riveted a thin plate of steel, called the water tripper. When not in operation, the water tripper lies flat along the surface of the torpedo. Before the torpedo is launched the water tripper is raised to a vertical position. When the torpedo is launched its rush through the water throws the water tripper down flat and releases the reducing valve to its full action.

Locking Gear.—When the torpedo is launched, the inertia of the pendulum causes it to lag to the rear, thus causing the torpedo to make a deep initial dive. To prevent this locking gear is provided, which locks the steering engine valve rod until the pendulum will act independently of its inertia. The locking gear is attached to the steering engine, and the locking is accomplished by means of the locking dial (Figs. 2 to 4), which is accessible through a hole in the shell, on the left side of the after body.

The ratchet bar connects with an arm cast on one cogged sector (called the ratchet bar sector, 8, Fig. 4) of a bevel gear, the other sector (called the sleeve sector) being cast on a sleeve. This sleeve, 10 (called the locking dial sleeve), is a cylinder, one of the faces of which appears as a flat ring when seen through the hole in the shell. It is the outer, in the system of locking dial and rudder index, and has two small slots to receive the pins of the wrench used in setting the locking dial.

Extending across the system is a setting bar, 11, having 11 divisions graduated on the upper surface near the middle. These divisions correspond to the 22 teeth of the ratchet bar, and each division will lock the rudder for a run of about 15 yards.

The flat ring (with two small holes in its surface) next to and just inside of the setting bar is the setting bar clamp nut, 12.

When the rudder is locked, the valve stem is held rigidly by a long locking arm, 18, projecting from a ring, called the locking ring, 15. A shorter arm, 19, projects from the opposite side of the ring, and is called the short locking arm. The two arms bear against the face of a flat, circular flange, 24 (called the locking flange), cast on a long sleeve (called the flange sleeve), which fits over a rigid spindle. The ring is pivoted midway between the arms on screws which screw into the locking ring carrier, 17. This is a thick cylinder, underneath the locking flange, which slides on a rigid spindle. A circular score, 28, is cut in the face of one end of the cylinder, in which a pin, rigidly attached to the locking flange, moves, and thus limits the motion of rotation of the flange around the spindle. The face of the other end of the cylinder has a segmental score planed out, which is the bearing surface on the cam on one end of the rudder index dial sleeve, 31.

The flange is cut away in two diametrically opposite sectors, each sector being about one-sixth of the circumference of the flange, and cut deep enough toward the center to permit fore and aft motion of the arms of the locking ring, 15, when the locking sleeve and flange are revolved to the proper position.

The flange and its sleeve also slide on the same spindle as the locking ring carrier, 17, the flange and carrier being held to position by a spring (around the spindle and inside the sleeve). Next to the spring is a washer, and next to the washer the ratchet bar sector arm, 8; all held in position on the spindle by a nut screwed on it next to the ratchet bar sector arm. This arm pivots around the spindle and supports the sector, of which it is part. Two deep slots are cut in the flange sleeve (diametrically opposite), and the ratchet bar sector arm, 8, fits in these slots snugly, so that the motion transmitted by the ratchet bar to the ratchet bar sector, 7, is transmitted by the latter to the flange sleeve and flange to release the locking ring, 15, and thus release the steering engine valve rod, 6, to action.

In locking the rudder the bevel gear is turned by a wrench with its two pins inserted in the slots of the sleeve. This draws the ratchet bar down. Its teeth engage with those of a small pinion. This pinion receives a motion of rotation from the engine when running, moves the ratchet bar up again, turns the locking sleeve, 23, until the arms from the ring are opposite the cutout portions of its rim, when the valve stem is unlocked, and the steering engine, 27, free to act.

Rudder Index.—This regulates the position (up, down or horizontal), in which the rudder is locked during the time the locking gear is in action. This regulates the depth of the initial dive of the torpedo.

The dial, 13, of the rudder index is on the left side of the torpedo. It is circular and graduated to 32 divisions on each side of the zero mark, and is turned by a wrench. It is clamped by the inner clamp at the center of the index, the outer clamp being for the locking dial.

The dial is on the face of a long sleeve, 10, the other face of which is a cam, bearing against a sleeve (called the rocking ring carrier, 17), on which pivots the locking ring, 15, with two arms.

The valve stem of the steering engine being locked by the locking gear, when the dial of the rudder index is revolved with a wrench, the valve stem is moved out or in by the cam on the rudder index dial sleeve moving the locking ring carrier, and with it the locking ring, the long arm of which moves the valve stem. Turning the dial to the right puts the rudder down, and to the left puts it up. Briefly, the rule is, the rudder moves in the same direction that the dial is turned.

Obry Gear.—The object of the Obry gear is to keep the torpedo on a straight course during a run. (Figs. 5 to 15.)

It is carried in the after compartment of the after body, just abaft the bulkhead to which the main engine is secured. It is put in place and may be removed through a door in the shell of the torpedo on the under side. Its frame is secured by square-headed screws to supports riveted to the shell of the torpedo.

The Obry consists, essentially, of a gyroscope controlling the motion of the valves of a steering engine, which operates two rigidly connected vertical rudders working in the forward top and bottom blades of the torpedo.

The gyroscope wheel (Fig. 9), of Tobin bronze, is 3 inches in diameter and weighs 1¾ lb. Its axis is in a fore and aft direction in the torpedo. The axle is fitted with tool-steel female centers, supported on male centers screwed through the inner ring. The inner and outer rings are fitted with steel female centers, and supported by screws, the inner ends of which form the male centers.

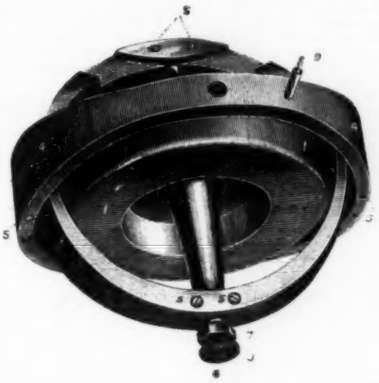

FIG. 9.

GYROSCOPE WHEEL WITH INNER AND OUTER RINGS, COUNTERBALANCE PIN FOR VALVE ARM, AND CLAMP SCREWS.

When the wheel and rings have been adjusted these screws are locked by locking screws. The after centering screw, 6, of the axle of the gyroscope wheel projects beyond the inner ring, is threaded, and carries a nut and jamb-nut, 7 and 8, which may be screwed toward or from the gyroscope wheel, 1, as counterbalance.

Screwing the counterbalance, 7 and 8, out causes the end of the axle of the gyroscope wheel to move to starboard in the torpedo, which will cause the torpedo to run to port; screwing the counterbalance in toward the gyroscope wheel will cause the torpedo to run to starboard.

The screws through the inner ring, 3, supporting the gyroscope wheel, may also be used for adjustment by moving the gyroscope wheel bodily in the direction of its axis inside the ring.

The outer ring, 4, has a small steel pin, 9, projecting outward, which actuates a steel yoke, 10 (called the valve arm), and gives the valve motion to the rolling valve, 11, of the steering engine, 12. The valve seat (called the valve plug, 13) is outside of the valve (which is cylindrical and hollow) and is, in shape, a hollow truncated cone, which may be moved within small limits around the valve by horizontal adjusting screws. Air is taken from the valve group, and, after passing through a reducing valve (which reduces the pressure to about 150 lb. per square inch), passes around the valve through the valve plug and to the steering engine. It exhausts through the valve plug and valve into the after body.

The adjusting screws, 14, of the valve plug are used to correct deviation of the torpedo either to right or left of a straight course. One screw must be slacked up before the other can be screwed in. Then screwing in the second screw draws the end of the valve plug into which it screws toward that side, and causes the torpedo to run toward the side of the first screw (the one slacked up). That is, the torpedo runs in the direction in which the screws are moved.

The motive power of the gyroscope wheel is a stiff steel spring, 15, wound by a key through a hole in the shell of the torpedo. The spring, when released, turns a cogged sector (called the impulse sector, 16), the cogs of which mesh with cogs on the forward axle of the gyroscope wheel, over 276° of the sector, and thus gives the gyroscope wheel a high speed of rotation. A sector of 84° is cut from the impulse sector, which allows the gyroscope wheel to continue its rotation after the cogs of the remaining 276° of the impulse sector have all passed the cogs on the axle of the gyroscope wheel.

By suitable connections with the starting lever of the main engine, the gyroscope is centered, before winding it up with the key, by putting the starting lever down flat along the shell of the torpedo. After winding the Obry, throwing back the starting lever releases the impulse spring, which then springs up the gyroscope wheel.

The tail of the torpedo consists of the part abaft the after body, comprising the gear box, the tail tube, and the frame of the tail. The latter consists of a forward and after cone, each carrying a pair of vertical flat blades and a pair of horizontal ones. The forward and after blades are joined stiffly together by rails. On the upper edge of the top rail is a guide which enters the guide slot in the tube in launching.

The gear box carries the bevel gears by which the motion of the main shaft is transmitted to the outer tubular shaft in a contrary direction. The propellers, of steel, are two-bladed, and are carried in tandem, the forward one right-handed, on the outer tubular shaft, and the after one left-handed, on the main shaft.

The horizontal rudder, of steel, is carried at the rear end of the tail, and is connected with the steering rod by a series of levers carried around the propeller on the lower vertical flat blades and lower rail.

The vertical vanes are set when the torpedo has its trial. They are pivoted at their forward ends, and can be swung on their pivots to starboard or port to give permanent rudder effect.

The propeller shaft is in two sections, the after one fitting as a sleeve over the forward one, to which it is held to revolution by four feathers and slots.

The tail may be removed by disconnecting the two steering rods and withdrawing the tail joint screws. When the Obry steering rod is disconnected, enter the screw in the locking hole of the tail cone to lock the rudder spindle yoke to hold the rudder amidships. In removing or putting in the horizontal rudder rod, take out the screw and the rod will more easily pass through the hole for it in the spindle of the vertical rudder.

In putting the tail on the after body, see that the marks on the two shaft sections coincide, so that the engine can be set to start without sticking on the center.

The vertical rudders are carried in the forward vertical flat blades, and are rigidly connected by a yoke around the starboard side of the propeller shafts. The steering rod from the Obry steering engine is connected to the yoke.

FIG. 10.

OBRY GEAR—WHEEL AND RINGS DISMOUNTED; ALSO IMPULSE SPRING AND ROLLING VALVE REMOVED.

PREPARATION, ON BOARD SHIP, OF THE MARK I. 5-METER 45-CENTIMETER WHITEHEAD TORPEDO FOR A RUN.

. . . . . .

Try hydrostatic piston to get the throw of horizontal rudder due to the action of the piston alone.

To do this, see the yoke on, level torpedo, and give

two or three turns to regulator, raise water tripper, raise starting lever; then work depth index with a socket wrench, screwing it up and down between graduations 0 and 5. This will give a total throw of the rudder of from 3¼ to 4½ divisions, and in all cases should give ¼ division more down-rudder than up-rudder. In case it does not give this much more down-rudder, lengthen the steering engine valve rod by turning the valve-adjusting screw to the right, by means of a small wrench inserted through a hole in the shell of the after body, just forward of the locking dial.

This adjustment is important, and if it cannot be made by the valve-adjusting screw, the steering engine rod will have to be lengthened or shortened (depending upon whether down or up rudder is required to give the ¼ division more down-rudder desired), by screwing the steering engine rod out or into the coupling just abaft the steering engine.

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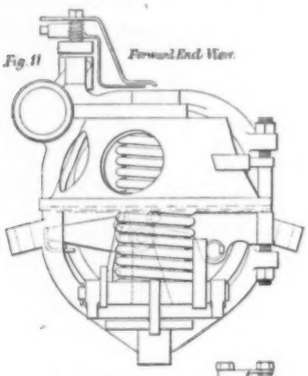
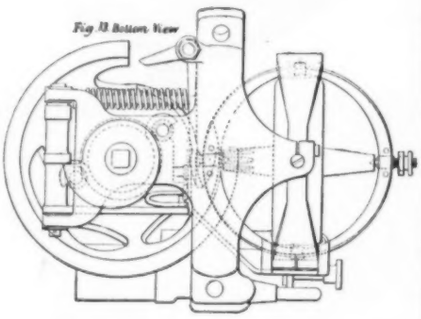
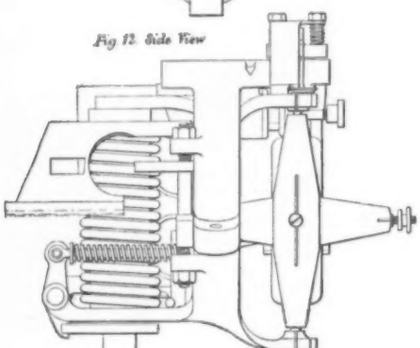
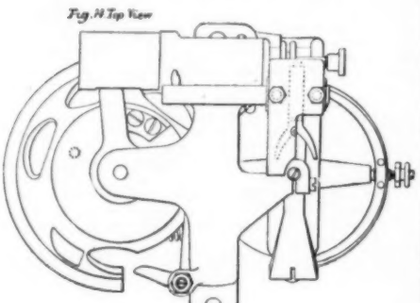
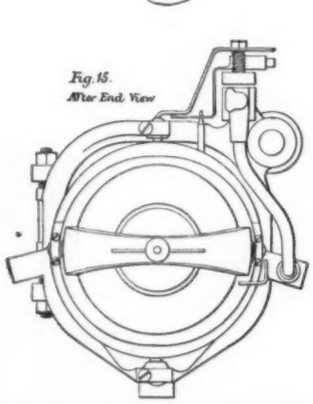
Obry Gear.—The action of the Obry gear upon the torpedo is to cause it to make a series of short curves, but to keep a mean straight course, varying but little from the line of sight. If the curves are long, or if the general direction taken by the torpedo is to the right or left of the line of sight, the Obry should be examined to see if it is properly adjusted.











THE OBRY DRIVING GEAR FOR WHITEHEAD TORPEDO.

In testing or adjusting the Obry on board ship, the ship's head should remain on the same compass course, for if the ship is swinging, the change in azimuth will have the same effect upon the result as though the torpedo had deviated from its course by the same amount as the ship has swung.

To Test the Obry while in the Torpedo.—See the starting lever down, raise the water tripper and put the yoke on the propellers. Put the transporting strap on and sling the torpedo so it may be swung in azimuth. Wind the Obry. Raise the starting lever, which starts the gyroscope wheel spinning by releasing the impulse spring. Swing the tail of the torpedo gently from side to side and note the angle or arc through which the tail moves when the vertical rudders move from one side of the torpedo to the other. If the Obry is working properly, the rudders should move from one side to the other when the tail is swung through an arc of 1 degree (½ degree each side of the central position); the extreme limit within which it is necessary to move the tail to work the rudders might very properly be considered as not more than 3 degrees of arc (1½ degrees each side of the central position). It should, however, be less than this.

Continue to swing the torpedo to the right and left from four to five minutes, and notice if the limiting points of the arc through which the tail is swung remain constant, or if it is necessary to swing the torpedo a little further to the right or left each time. If such is the case, and the ship is steady, then the gyroscope wheel is probably not keeping in the same plane as it should. It will therefore be necessary to adjust the Obry.

To Adjust the Obry Gear.—Take out the screws of the Obry door and remove the door. Unscrew the holding-down screws of the Obry with a socket wrench and lift the Obry out of the torpedo. Put it in the adjusting stand and screw in the holding-down screws (Figs. 5, 6, and 8).

Swing the starting lever (on the adjusting stand) round in the direction the hands of a watch move, as far as it will go.

Wind the Obry, noting that the impulse sector meshes properly with the teeth on the gyroscope axle.

Have a watch ready to note the duration of the time the Obry will run. (They run from 10 to 11 minutes, when adjusted in the shops where made.)

Trip the impulse spring by moving the starting lever back in the opposite direction to the motion of the hands of a watch, seeing that it remains in the position to which moved and does not fly back.

Set a pointer on the stand, close to the end of the center on which the counterbalance is screwed, so that its motion (if any) may be carefully noted. (This is the after center on which the gyroscope wheel turns when the Obry is in the torpedo.)

If this center moves to left against the hands of a watch, the counterbalance is too heavy, and must be screwed toward the ring.

If the after center moves to the right, the counterbalance is not exerting weight enough on the wheel, and must be screwed out.

If the horizontal motion, to right or left, of the after center cannot be overcome by moving the counterbalance into the ring, or out to the end of the screw upon which it is screwed, then the gyroscope wheel itself will have to be moved in the same direction. To do this slacken the clamp screws of both centers, unscrew one center about one-quarter of a turn, then screw the other one in carefully the same amount. The wheel will be found very sensitive to this adjustment. See that the wheel turns freely on its centers, then set up the clamp screws.

Wind up the Obry and try the running of the wheel again. Continue the operation until there is no horizontal motion of the centers of the wheel, and, of course, of the wheel itself.

If the centers of the gyroscope wheel have a vertical motion, after the horizontal motion has been overcome, it probably indicates that the gyroscope wheel is too near the ring-bearing of one of its centers and too far away from the other. Moving it back to the proper position would introduce a horizontal motion of its centers. The vertical motion would probably not interfere with the proper action of the Obry, however (unless the torpedo rolled), except in cases when it was so marked that the wheel had turned up to a position where the gyroscopic action was interfered with before the torpedo had finished its run.

The vertical motion might be overcome by moving the wheel in the direction of its centers until in the proper position, and then filing from the heavier side of the ring.

The wheel is nearer the ring-bearing of that center which has a vertical motion upward when the wheel is running.

Having adjusted the gyroscope, so the centers of the wheel do not move in azimuth while the wheel is running, make the air connections and turn on a pressure of about 150 pounds on the steering engine.

Wind up and start the Obry, and then work the frame of the adjusting stand back and forth to get an indicator diagram. This will show the action of the rolling valve of the steering engine. Excellent cards have been taken by moving the frame through an arc of 1 degree (½ degree each side of center).

If the card shows that the torpedo would have a tendency to run either to port or starboard of the line of sight (through the action of the Obry), counteract this tendency by setting the valve plug by the adjusting screws of the valve.

One screw must be slacked up before the other can be screwed in. The torpedo will run in the direction in which the screws are moved.

For some of the engravings we are indebted to London Engineering, but this journal is, in turn, indebted to The Proceedings of the United States Naval Institute, vol. xxiv., No. 1. Our article is taken from the latter publication.

ANNEALING MALLEABLE CASTINGS.*

By ALEXANDER CAIRNS.

CASTINGS to be annealed are cleaned in the tumbler, pickled, sand blasted, or not cleaned at all, depending on the shop practice. Small castings, such as saddlery and carriage hardware, agricultural and similar classes of work, are annealed in a satisfactory manner with the sand on them. Large castings are milled or cleaned in the tumblers as a rule, although, if packed without cleaning, will require reannealing.

Furnaces.—The furnaces used to anneal are rectangular in section, about 10 feet wide and 18 feet long, and 8 feet high in the center of the arch. The fireplace is set on the inside in one corner of the oven, and usually the grate surface is 2 feet 6 inches by 6 feet, extending upward to within 8 inches of the roof of the furnace. The flues extend along each side, on a level with the floor, and should be about 4½ inches by 9 inches, so that a stock firebrick will just fit them. It often happens that a furnace which is one of a number entering the same stack will not work according to calculations, in which case the flues are stopped up or left open until the furnace has been found to work right. Various forms of doors are used for these furnaces, that in which the brick are set in a permanent sling being the most prevalent.

Annealing Pots.—Malleable cast iron castings are annealed in rectangular sectioned castings called pots, which are set upon a bottom and built four or five high, making one continuous pot from the bottom up. According to the character of the work, the continuous pots are divided by setting plates between each of the sections so as to keep the castings separate. They vary in size from 12 inches wide, 24 inches long, 18 inches deep, and ½ inch thick for light castings to 30 inches wide, 72 inches long, 18 inches deep, and 1½ inches thick for the longer classes of jobbing and railroad castings. At times it is advisable to make special sections in round, square, and triangular shapes, when the order on the particular casting will warrant the expense. Such castings for which there are no pots, and for which it is not advisable to make them, are bricked up in the furnace with fire brick and firmly bedded in and covered with packing. The bottom plates are made the same size as the pots, and from 2 inches to 3 inches thick, and sufficiently high to admit of easy handling with the truck. The pot sections are moulded in green sand, cast from the cupola, do not become annealed in use, and will last from 15 to 18 heats. In order to secure the best service from them, it is necessary that a fairly good quality of iron be used.

Packing the Castings.—Packing is a shop term applied to the class of materials used to pack the castings so that they will retain their shape when hot. It is also applied to the materials which answer the above purpose and in addition supply oxygen or have the latter in their composition. A number of different materials are used for the former purpose which are used principally on light castings. Almost anything that will stand up well while hot is suitable, like ground burned firebrick, iron borings, and sand. As they of themselves do not supply oxygen, it is necessary in using them that oxygen be obtained by means of a coating of rust or oxide upon the castings either before or after charging the pots. In rusting them before, much of the oxide becomes rubbed off in packing. Packing the castings wet would do, provided there was some certainty of their being oxidized before heating. Wetting the packing with dilute ammonia is a very sure means, and, in the absence of anything better than ammonia, is the most satisfactory way of handling this material.

The use of this class of packing has evidently been confounded by Mr. Davis in a former paper with the process described by Forquignon, with which it has no relation, but is rather the Reaumur process, with the source of oxygen formed on the castings by oxidizing them instead of the packing furnishing the oxygen. Of the latter class of packing, forge scale and hematite ore are used. I am familiar with the former only. It is an iron oxide, and becomes more desirable as a packing the longer it is used, for the reason of its finer division and consequently lying closer to the casting. In using this packing on castings cleaned, or those having the sand upon them, no effort toward forming an oxide upon the casting is necessary, although the formation of such oxide saves the packing; that is to say, less of the oxygen in the packing is consumed. New or green packing is worked in gradually on the heavier work.

Packing or charging castings in the pots, so that they retain their shape and do not scale or hang while hot, is a process that cannot be well described. In general they should be packed with a view to keeping the packing in close contact with the castings during the settling of the contents of the pot. For instance, flat plates or sections should be packed on edge; if on the side, they will scale on the bottom, from which the packings have settled. This explains why some castings scale and others do not in the same pot. Castings having projections or unequal sides, which can therefore be stacked on top of each other, are built up from the bottom plate with a view to balancing the pile. All long sections and all castings, unless packed in pots that will admit of their being placed horizontally, should be set upon the bottom plate vertically. I have seen castings 5 feet long become ¾ inch longer than the pattern, because they were packed

* Paper read before the Philadelphia Foundrymen's Association.

some inches above the bottom plate and hung in the pot during settling. As a general rule, there is a relation between the amount of the packing and the castings, or between the oxygen in the packing and the carbon in the castings; there can therefore be a condition where there is not sufficient packing between the castings to anneal. There should always be an excess in favor of the packing. The packing of the castings is carried upward with a view to meeting the unequal heating of the pots—that is, heavy castings in the top and light ones in the bottom, separated by plates when the occasion requires it. Beginning with the bottom plate, the first pot is usually a new one. They do not take the heat readily, on account of the sand upon them, and for this reason should be broken in on top. Owing to their weight, however, it is not practical to use them there. Building or packing continues upward, the pots being placed according to their age, the top pots passing out of service.

Annealing Without Packing.—The matter of packing castings is attended with many difficulties which materially add to cost, and which can only be overcome by long experience and observation. The author has been perfecting a method of annealing castings, on which patents are contemplated, without packing them. The method will apply in particular to that class of complicated shapes on which the handling and labor of packing and straightening constitute an important item.

The pots, some 55 to 65 in all, holding from 20 to 22 tons of castings, are set into the furnace with space about equal to their bulk between them and the walls. Those containing the heavier castings are placed in the center. The furnace is closed up and firing is continued for three days, the door removed and the pots taken out. They may be allowed to stand for some time, depending upon what the laborer engaged in handling them may be doing. Under ordinary conditions the first 24 hours' firing shows the pot a red heat, and on the third day they are a bright yellow, and can be readily distinguished in the furnace. Firing on the last day stops with the disappearance of carbonic oxide flame. There is no regular length of time for this flame to burn. It depends on the relative proportions of castings to packing or carbon to oxygen. Its disappearance usually is not an indication that thorough annealing has taken place, although it may be, but is rather an evidence that the oxygen in the packing immediately adjacent to the casting has been consumed, spent, or used up. If it were possible to raise the pots to the necessary temperature in 12 hours, annealing would take place just the same. Experiments that accomplished this, but were made with a view to saving the fuel used in the furnaces, were made some years ago in New York. The pots were set into the flue of the furnace, but as there was no satisfactory way of controlling the temperature at that time, annealing by this means was discontinued. Small or medium sized castings can be annealed in a few hours by packing in a hand ladle, removing a few bricks from the side of the furnace, and setting in on top of one of the pots with a pair of tongs. Large lots of castings are annealed in from one and one-half to two days by selecting the furnace nearest the stack and enlarging the flue area—that is, taking out a few bricks with which some of the flues had been stopped. If the pots are five sections high, the top section only is packed, the lower one being empty, having plates set in between them, so as to raise the top pots as near the roof of the furnaces as practicable. As soon as annealing is indicated, the firing should slack off and the pots be allowed to soak until the flame has disappeared.

Malleable Castings Without Annealing.—The manufacture of malleable castings without annealing has received much attention from practical men in the business, and one direct result of experiment in this line has been the discovery of a mixture 1½ per cent. of which renders the castings workable to some extent, but they are in no sense malleable. This class of iron has been used in steel ranges and castings wanted in a hurry.

On the whole, the process of annealing is a very simple one, and there are apparently mysterious happenings that are due to quite simple causes. Owing to the variations in the working of the furnace, a heat is occasionally burned in the top pots. This is a matter of firing, and is not common in old furnaces that have been experimented with until found to work right, but cannot be avoided entirely in new ones. Heats are often withdrawn and found to be not annealed. This is an evidence that the furnace was not hot enough and that it was not properly watched. Heats of this kind are returned to the furnace and fired over.

ENGLISH DUMDUM BULLETS.

DURING the Chitral campaign of 1895, the Indian troops found that the nickel-covered leaden bullets of their Lee-Metford rifles were ineffective against living targets. The soldiers overcame this difficulty by stripping the bullet partially of its nickel jacket and exposing the ogival point of the head. These Dumdum bullets, so named after the Dumdum Ammunition Works, at Calcutta, became distorted on striking a soft body and were torn apart, as shown in Fig. 1. The wounds produced by these half-covered bullets were found to be very serious.

Considerable comment has been excited and much opposition raised by the fact that the English government has supplied its troops with bullets having arsenical or cuprous nickel jackets thickened at their rear ends, but so thin at their forward extremities that the lead is almost exposed. It is said that the English troops are to use similar ammunition in their revolvers (Figs. 2, *a* and *b*). These new bullets penetrate six inches into a body and produce a jagged hole, as shown in Fig. 2 *c*, from three to four inches in diameter. The Geneva Convention, it is true only prohibited the use of explosive bullets in small arms, but had the Convention known of the terrible effect which could be produced by a bullet of the form described, mankind would undoubtedly have been protected from this new and fearful type of shot.

True it is, that compietely jacketed bullets are comparatively harmless against living targets, since they merely pass through the body with but little injury. But it is not on that account necessary to employ these highly destructive, half-covered bullets with their expansible soft cores. Experiments should be made either with fully covered shot having flattened heads or with an entirely new form of bullet, since a flat-headed projectile has too small an initial velocity for use in modern warfare. In the Kriegstechnische

FIG. 1.

Zeitschrift, to which we are indebted for our illustrations and particulars, a writer proposes a construction similar to that shown in Fig. 3. In this proposed form, a core, *a*, a jacket, *b*, and a leaden cap, *c*, are used. The jacket, *b*, is formed with a contraction, *d*, which offers a firm hold for the leaden cap, *c*. The inventor of this bullet is of the opinion that a projectile of this type will lose nothing in velocity, and that upon

FIG. 2.

striking a human body it will not be distorted to so great a degree as the half-covered Dum Dum bullet. By reason of the tapered head, *e*, a mushroom-like formation will result on impact, as shown in Fig. 4, and a rather large passageway will be produced without tearing apart the surrounding muscles so terribly as in the case of the half-jacketed bullet. A further advantage claimed for this shot is its high penetrating

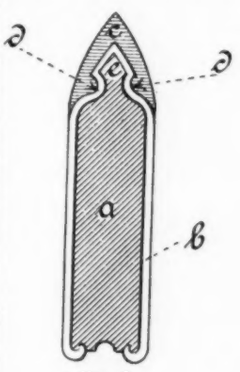


FIG. 3.

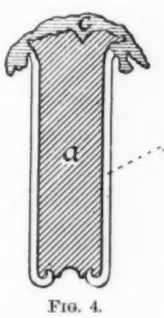


FIG. 4.

power, since the easily demolished leaden cap readily permits the hardened head to protrude.

ANCIENT AND MODERN INKS.

IT is frequently stated that since the medieval ages the art of ink-making has shown decided signs of retrogression, and, as evidence of this deplorable fact, mention is made of certain documents written six to eight centuries ago which, when compared with many writings of less than a hundred years of age, show far greater legibility and a more perfect degree of preservation.

It is probable, however, that the inferior ink has come into use during the last few centuries, not so much through ignorance concerning the manufacture of more permanent ink, as through the desire to employ an ink which would not deteriorate by settlement, and which would, by more perfect fluidity, be more conducive to rapid writing than the ancient inks.

Vitruvius, Pliny, and Dioscorides each mention ink as containing soot or lampblack mixed with some mucilaginous fluid; and although even in their day a dye was also sometimes added, there appears to be little doubt that the legibility of ancient records is due to the use of carbon as the basis of the ink; and that when, toward the close of the medieval period, the element carbon began to be discarded altogether as an ingredient of ink, the fading of manuscripts became more rapid.

Many years ago an ink receptacle was found at Herculaneum which contained a small quantity of ink. On examination this proved to be composed simply of lampblack mixed with a thick oil, and it is supposed that this is the description of ink which was used for writing upon papyri at the time of the destruction of Herculaneum.

Such ink must have required frequent stirring, and the writing was probably performed with a fine brush. "The lampblack," says Underwood, "was ground up with the oil as painters' colors are now done, and by remembering this, we can understand the meaning of Demosthenes when, in a speech of his, he taunts his great rival Æschines for having been compelled in his youth, through poverty, to sweep the school, sponge the benches, and grind the ink."

The rapidity with which carbon settles out from the liquid in which it is suspended, and the poor fluidity of a mixture of carbon and mucilaginous liquid, prohibit its use for modern commercial purposes; there is evidence also that writers in the early centuries endeavored to replace it by some more convenient substance, for Mr. Astle, the author of a book published toward the close of the last century, mentions that he possesses a parchment roll requesting prayers for the Countess of Oxford, who died in 1199. This roll contains certificates from many of the religious houses flourishing in England at that time, and it is observed that, whereas some of them are as black as if recently written, others are brown, and some of a yellow hue.

The extract of gall nuts, or other tannin matter, in combination with an iron salt, which forms the basis of most black writing inks of the present day, was in use many centuries ago, but it appears to have at first been mixed with soot or lampblack, which, however, seems to have gradually been discarded. The blue-black inks of the present day consist generally of this tannate or gallo-tannate of iron suspended in water containing gum, and mixed with indigo or some similar coloring matter.

Colored inks, consisting probably of vegetable extracts, were known to the ancients. The Sacrum Encaustum was a purple ink, and a green ink was reserved by the Greeks for state purposes. The colored inks of to-day are frequently simple solutions of aniline dyes; but logwood and other vegetable dyes are still used to a considerable extent. A somewhat remarkable production of the present age is the preparation of a fireproof ink with a platinum salt for its basis, to be used in conjunction with a fireproof paper composed largely of asbestos.

Before leaving the subject of writing inks, mention must be made of the changes which have taken place in the manufacture of paper during modern times, for the quality of the paper largely influences the permanency of the ink. The parchment skins which were formerly used for writing upon were far superior to our modern paper, so far as preservation of the written record is concerned; even the old unbleached paper was superior to the modern bleached and glazed material, for small quantities of chlorine and lime always remain in the paper, and apparently exert a detrimental effect upon both paper and ink in the course of time. The result of using wood pulp for paper making may already be seen in many books, in which the paper has turned to a brown color and become so brittle that it may be broken into small pieces by merely crumpling it in the hand.

The ink in use at the present day by draughtsmen for drawing purposes appears to be very similar to that formerly used for ordinary writing purposes. In this country it is most commonly known as "Indian ink," although it appears to be most extensively manufactured in China, several factories for preparing the ink being in existence at Shanghai and other parts of the Chinese empire. To this day it is often used as a writing ink in China, Japan, and other Asiatic countries, a small brush taking the place of a pen.

This ink is merely a mixture of carbon and gum, with the addition of a small quantity of musk, or Borneo camphor, to give it the characteristic peculiar odor. But the preparation of this simple ink is by no means easy, for unless the materials are of the finest quality and the carbon as finely divided as it is possible to obtain it, an inferior ink will result. At the same time there are no extraordinary properties about real Chinese ink, as Europeans have been able to manufacture ink equal in quality if not superior to that which comes from the far East. The chief drawback to European ink is that the European manufacturer is apt to seize upon the first opportunity of substituting cheaper raw materials, whereas the tendency of Chinamen is to remain in statu quo throughout eternity.

After the carbon and gum have been mixed, the product has to be slowly and carefully dried. The moulding of the sticks is effected in moulds engraved on the inside with Chinese characters, such as the well known dragon, etc., and the gilding is performed with gold leaf. The high polish of the sticks is said to be produced by brushing them with a hard brush impregnated with tree wax. A good sample of Chinese or Indian ink is fine-grained and homogeneous throughout, does not deteriorate with age, and will produce lines of perfect regularity of tint.—The Builder.

In the French quarries of St. Triphon stone is sawed with steel wire cables moistened with wet sand, and passing in an endless rope over a series of pulleys. The wire, which runs from 1,000 to 1,200 feet per minute, is charged as it enters the cut with a jet of water and siliceous sand, which forms the cutting material. A running cable of 500 feet can make a cut 100 feet long. To remove a ledge, pits 3 feet in diameter are dug to the depth of the desired cut and the stone sawed vertically in slabs to the bottom, being then easily split off by wedges. The slabs are removed by an electric traveling crane and sawed to any desired size.—Invention.

ENGINEERING NOTES.

An automatic 1-pounder gun, capable of firing 180 shots per minute, is being tested at Indian Head. It is especially intended for use against torpedo boats, and its effectiveness for such a use is apparent.

The big order for naval vessels which the Cramp's have just secured from the Russian government has hastened extensive improvements to the shipbuilding plant of that firm, which have been in contemplation for some time. Contracts are being let for a system of overhead cranes, the Brown system of hoisting and conveying machinery, and for numerous new tools.

As misapprehension is apt to enter into the minds of some engineers as to the relative size of exhaust pipes in condensing and non-condensing engines, it may be well to give the experience which is described in the May number of Power. In a steam engine, the port area of which was sacrificed to compactness to an extent involving a back pressure of about two pounds when the engine was exhausting into the atmosphere, it was found that when running condensing there was scarcely a perceptible difference between the pressure realized in the cylinder and that of the condenser. In another instance an engine was running with an exhaust pipe which the average designer would have thought too small for the cylinder. This engine was reconstructed with a larger cylinder, and naturally the designer said that the exhaust pipe would have to be changed, but to avoid loss of time, the cylinder was temporarily joined to the existing exhaust pipe. To the surprise of the designer, the diagram showed that an excellent vacuum was realized in the cylinder, differing very little from that in the condenser. Thus the popular impression that the exhaust pipe of a condensing engine should be especially large was shown to be erroneous.

Train resistance, with its multitude of factors, has puzzled not a few inquirers. Prof. Goss has recently gone very closely into the subject in America, and has constructed apparatus with which he has carefully experimented in order to try and find out all about it. He recently told the Western Railway Club all he had learned and how he had learned it. The conclusions at which he arrived are as follows: 1. The force with which the air current acts upon each element of the train, or upon the train as a whole, increases as the square of the velocity. 2. The effect upon a single model, standing alone, measured in terms of the pressure per unit area of cross-section, is approximately 0·5, the pressure per unit area as shown by the gage recording the pressure of the air current. 3. The effect upon the different models composing a train varies with different positions in the train; it is most pronounced upon the first model, the last model coming next in order, then all the intermediate models excepting the second, and least of all is the effect of the air upon the second model. 4. The relative effect upon different portions of a train is approximately the same for all velocities. 5. The ratio of the effect upon each of the several models composing a train, measured in pressure per unit area of cross-section, compared with the pressure per unit area of the air current as shown by the gage, is approximately: For the first model, 0·4; for the last model, 0·1; for any intermediate model between the second and last, 0·04; and for the second model, 0·032.

On the Marne-Saône Canal, now being completed, there is one reach of 3 kilometers length with a gradient of 41 meters, *i. e.*, almost 1·5 per cent. The minister for public works decided that this rise should be overcome either by hydraulic lifts, not more than four in number, or by means of locks, and invited tenders from French and foreign engineers. In 1893, already the first prize of 20,000 francs was accorded to James and Alexander Leslie, who proposed eight locks, each with a rise of 5·125 meters, and a year later a second prize of 10,000 francs was given to the Fives-Lille Company, who submitted a similar project. These locks have been adopted. Last year the government arranged for the publication in extenso of the thirteen other projects with complete calculations. These papers fill three volumes, each of more than 800 pages. The volumes form a very important contribution to this branch of literature, and the Nouvelles Annales de la Construction are doing good work by publishing an exhaustive summary of the various projects, leaving out theoretical calculations and matters of purely local interest. The first of that series of articles appeared in the May issue of the journal, and is illustrated by a number of plates. Conspicuous among the projects are the proposals of hydraulic or floating lifts. Apart from the Fives-Lille Company, all the engineers suggested balance compensators, chains, etc., for the bridges and troughs raised by means of hydraulic rams. None of the projects were distinguished by novel principles, but it is not often that so detailed information is offered.

Capt. M. H. P. Riall Sankey, in a paper read at the engineering conference in London last year, after briefly discussing the advantages of the metric system, described the results of its introduction into the works of Messrs. Willans & Robinson, says The Engineering and Mining Journal. Wherever gages and templates were used, the question of their measurement in inches or millimeters was not a matter of much importance. The old drawings were therefore still employed for the earlier sizes of engines, but the templates and gages were marked with the millimeter equivalent to the third place of decimals in order to accustom the men to the new unit. All new drawings were made on the metric system. Some difficulty was met with in connection with the screw threads. The Whitworth and gas threads had been retained, but the bodies of the bolts were turned slightly larger than usual for each size, so as to bring them up to even millimeters, and thus to enable the bored holes to take the corresponding screw cut to the standard used by the French makers of the engine. After four years' working, the draughtsmen were practically unanimous in favor of metric measures, as being easier to check and to read, and requiring a smaller number of figures. No serious mistakes had been traceable to the change, and very few minor ones. In the shops, the old system was preferred at first, the new figures conveying very little idea of size, but the men were now much in favor of the millimeter. The works manager considered it easier to teach men the use of the rule with the metric than with English measures.

ELECTRICAL NOTES.

Dr. Alfred Brunn and Herr Viktor Takács, of Budapest, have designed an electrically worked underground tubular post for letters and parcels, which has been submitted to the Hungarian postal authorities. It has been decided to lay down a trial line from the eastern to the western railway stations in Budapest, and, if a year's working proves successful, the postal authorities will take over the line, and a scheme for connecting twenty-three offices on both sides of the Danube will be carried out.

There are 1,459 submarine cables, 1,141 of which are laid along coasts and in rivers, says The Railway Review. The total length of cable is 162,928 miles. Of this mileage corporations own 143,024, and of the companies themselves 76 per cent. are managed in London. France commands 12 cables, measuring 2,033 nautical miles in European waters, and 33 cables, measuring 26,356 miles in colonial waters. Germany controls 11 cables of 3,040 nautical miles in European waters and 3 cables of 470 miles in colonial waters.

In his annual report the Astronomer Royal writes: "Small agitations, due to the running of trains on the South London Electric Railway, the nearest point of which is at a distance of four and one-half miles from the observatory, can be seen in the horizontal force and vertical forces synchronizing with the disturbances in the earth current registers. These small effects can be traced from the year 1890, but, owing to the distance of this electric railway, they do not seriously interfere with the magnetic registers. A proposal which has been recently made in a bill before Parliament to use electricity for a proposed tramline in the neighborhood of the Deptford cattle market, at a much less distance from the observatory (one and one-quarter miles), would probably, if carried out, have destroyed the value of our magnetic records, and it has been successfully opposed."

L'Eclairage Electrique states that the cost per kilometer of electrical vehicles at the time trials in Paris was about 0·05 franc, on the basis of a charge of 0·3 franc per kilowatt-hour, at which price it is sold in the section of the Place Clichy. Each vehicle, in fact, expended current to the extent of 2¼ to 3½ francs' worth on the route of 60 kilometers, the current consumed varying from 9·73 kilowatt-hours up to nearly 14 kilowatt-hours in different vehicles. Petroleum vehicles cost very much more. The minimum consumption of petroleum by the Peugeot vehicle was 13 liters per day. Petroleum cannot be bought for less than 0·6 franc per liter. Thus the journey cost would be 7·8 francs, or practically 78 pence for 39 miles, being practically 2 pence per mile—an amount heavy enough for two persons, being equal to a third-class railway fare. The expense in repairs, etc., of the electric accumulators has been given at 3 francs per day per vehicle. Added to the cost of the energy, this implies a cost of about 6 francs, as against 7·8 for petroleum—not a wide difference, after all, but sufficient to show the success of electric vehicles in city work, and establishing this form of energy as cheaper than others.

The famous city of Granada, in Spain, has had a small 70 horse power electric installation since 1893. Last year a new plant of 700 horse power was added. The power is taken from the Jenil River, in the Sierra Nevada. There is, according to Le Génie Civil, first a canal, 7 feet wide, over 3 feet water depth, 3 miles in length, following a gorge, the sharp corners of which are cut off by tunnels, one 200 yards long. This canal is partly covered in to protect it against avalanches, and crosses other rivulets. Then follow two tubes, about 300 yards long, with inclinations of 33 and 65 per cent., and a total head of 340 feet. The tubes, each 20 feet long, of five riveted Siemens-Martin steel plates, were supplied by the Aznar foundry, at Hermano-Alicante; the thickness of the plates increases from 0·15 to 0·55 inch. The five Piccard-Pictet turbines are coupled with their dynamos. The whole electric outfit was supplied by the Alioth Company, of Basel. The power plant is 6 miles from the city. Two conductors of 0·3 inch are strung on poles, which are buried from 5 to 6 feet deep in the very dry soil, on triple insulators. The wires carrying the monophase currents of 4,000 volts are 28 feet above ground, the telephone wires 5 feet lower on the same poles. The line ends in a tower near the town; one of the transformer stations is in the Alhambra. The gas company of the city has installed another Alioth plant, also of 700 horse power.

The post office authorities have laid about 40 miles of the large telephone and telegraph trunk line cable which is to extend from London to Birmingham, and to which reference was recently made in The Daily Mail. The laying of this cable is by far the largest piece of work the authorities have undertaken since they had control of the telegraphs. The cable, which is being manufactured by the British Insulated Wire Company, at their works at Prescott, has a total diameter of 2⅝ inches, and the weight of each mile of cable is about 22 tons. It is made up of 76 separately insulated wires, each mile of which weighs 150 pounds. The manner in which the cable is constructed is interesting. Each conductor is separately inclosed in a tube of paper, so that it is entirely surrounded with air. The object of this is to get as much air around the conductors as possible without increasing the size of the cable. Air has a lower capacity than any known substance, and low capacity on a cable is equivalent to small absorption of current. This means that speaking is possible over a greater distance than under any other circumstances, and it was not until a cable was invented on this principle that it became possible to speak over any considerable distance by means of underground wires. The ordinary overhead wires are, of course, always surrounded by air, and this is why speaking is possible over such great distances, but long lines and many wires "cross talk," and the danger of breakage renders this system very troublesome and expensive. On the new cable the conductors are made up in pairs, the wires stranded together round one another, and the whole covered with a heavy sheathing of lead. At intervals of five miles pillars are erected, and at these points dry air is to be forced through the spaces into the cables, so that, if the lead sheathing should become punctured, the presence of the hole will be instantly discovered.

SELECTED FORMULÆ.

Water-tight Preparation for Wooden Dishes.—(1) Common brown resin, half pound; beeswax, two ounces. Melt together in tin pan (preserved meat tin will do); when quite fluid, run solution rapidly all over where required. Wood must be perfectly dry and warm. (2) Soak half pound of best glue in cold water until quite soft, melt in the glue kettle. When quite dissolved, pour in one ounce of hot saturated solution of bichromate of potash, and stir well. It is now ready for use; apply with brush. Put the article so treated to dry in full daylight for a day or two, and then apply strong alum solution. The vessel is now ready for use, but must be washed first.—Photogram.

Coating for Metallic Reservoirs.—A French process consists in mixing intimately barium sulphate with albumen, and using the paste received for painting the metallic surfaces to be protected. The tank must first be cleaned with soda lye, then it is painted with a priming coat, which is dried by the application of heat until hard. Then the reservoir is furnished with a second coating, which is also dried. The coat is exposed to the action of steam or boiling water, which causes the white of egg to coagulate. Finally, the whole is once more moistened with albumen, and steam or boiling water is used again. This paint is extremely resisting and durable against mechanical as well as chemical agents. It adheres so firmly that it can only be scratched off by means of sharp instruments. Finally, this coating does not crack or scale off, even if the reservoir receives knocks and dents.

Soldering Acids and Fluxes.—In a paper read at the March meeting of the American Institute of Electrical Engineers, says The American Electrician, Prof. R. A. Fessenden said that the ordinary soldering acid, which is a solution of chloride of zinc, is harmful to cellulose fabrics, which it turns into a paste. It never evaporates, but always takes up moisture from the air, and will gradually eat its way through quite a thickness of insulation. Whether it is acid or neutral makes no difference, so far as its action on the insulation is concerned, though the neutral solution does not corrode the wire. Resin has the disadvantage that it is not a fluid and it is clumsy to handle. Prof. Fessenden found that by shaking up powdered resin in very strong ammonia, an ammonia soap is produced which works well in most cases; the ammonia dissolves the copper oxide and evaporates afterward, leaving the powdered resin, which is an insulator.

Deodorant Tooth Powder.—

Menthol	10 centigrammes
β-naphthol	5 "
Saccharin	25 milligrammes
Cretæ precipitat	50 grammes
Sap. med	50 centigrammes
Ol. rosæ, q. s.	

Violet Tooth Powder.—

β-naphthol	5 centigrammes
Saccharin	25 milligrammes
Sap. med	1 gramme
Calcium carbon precipitat	50 "
Ionone and ol. cananga, 1 or 2 drops of each.	

—Pharm. Zeitsch. f. Russl., xxxvi., 696.

Iodine Tincture for Dental Work.—Iodine crystals are dissolved in absolute alcohol until completely saturated. A mixture is then made of a third of this solution, a third of aconite tincture, and a third of chloroform.—Zahnt. Reform, xvii., 451.

Lac for Cavities.—Dissolve copal resin in equal parts of alcohol and chloroform, and add an equal volume of hydronaphthol. The result is a thin adhesive lac of highly antiseptic, but non-irritating properties.—Zahn. Rundsch., vii., 4091, after American Weekly.

To Stop Bleeding.—Wicks recommends the following application as a hemostatic:

Resin, powdered	4
Carbolic acid, 95 per cent	3
Chloroform	2

Make a cone of wadding, saturate one end with the solution, and press firmly into the wound. The tampon can be removed after a few hours.—Zahnteeh. Reform, xvii., 452.

Nail Bleach and Polish.—A solution of oxalic or tartaric acid may be used as a "bleach." Try the following:

Tartaric acid	30 grains
Rose water	1 ounce

Most nail polishes, however, contain oxide of tin, and may be either pastes or powders. The following preparation has been found very satisfactory:

Oxide of tin	2 pounds
Carmine	3 drachms
Oil bergamot	75 grains
Oil lavender	75 "

NAIL VARNISH OR POLISH.

Paraffin wax	60 grains
Chloroform	2 ounces
Oil rose	3 drops

FINGER NAIL DRESSING.

The Era Formulary gives the following formula:

Sulphuric acid	5 drops
Tincture of myrrh	1 drachm
Water to make	4 ounces

Mix. First clean the nails with a stiff brush and soap, and then plunge them into the above mixture and hold them there for five minutes.—Pharmaceutical Era.

Recovery of Silver from Photographic Baths.—Randolph Bolling describes a new method of recovering silver from fixing baths. Having had occasion to make an analysis of photographic fixing baths, to determine the amount of silver present in combination with the sodium thiosulphate, the unoxidized silver salts on the developed plate were dissolved in a solution of thiosulphate to form a salt having the formula $NaAgS_2O_3$. The silver was first precipitated by ammonium sulphide as black silver sulphide. This was then separated by filtration from the liquid, and after being washed three times with hot water was dried and heated on charcoal until the sulphur was driven off.—Scientific American.

THE HIGH BUILDINGS OF THE ANCIENTS.

To Prof. Lanciani is due the credit of the discovery that there were building laws in Rome long before the Christian era. As the price of urban property increased, the landlords were forced to build high, and 200 years before the time of Christ the height of Roman tenements became alarming to those having the care of the public safety.

There are frequent allusions among the Roman historians, orators, and poets to the enormous height of the tenement buildings of Rome, but no definite figures are given until the days of Augustus, when a law was promulgated by the Senate which fixed the height of new structures at 60 feet on the street front, without making any allusion to the height of the rear. It is, however, known that in the rear these tenement buildings rose often several stories higher than in the front, so that from a distant height, as from the top of a temple which commanded an extensive view, a row of tenement buildings in Rome presented the appearance of a terrace—highest in the rear and descending by stories toward the front. This law of Augustus applied to new buildings, respect then, as now, being shown for investments already made. The number of stories on the street front of these Roman buildings was generally ten to twelve, with fourteen or fifteen in the rear. The lowest stories were 8 or 10 feet in height, but, from accounts given by the writers of that time, the stories appear to have gradually diminished as their height above the ground increased, so that the topmost tenants lived in quarters where very often they could not stand erect. That the stories were sometimes much less than 5 feet is shown by the discoveries in Pompeii, where, in a house inhabited, presumably, by poor tenants, a story of 4 feet 3 inches has been discovered. This was a living room, too, for in it were found all the articles which pertained to Roman housekeeping: cooking utensils, beds, stools, mirrors, combs, brushes, and other things which, with the bones of the family, furnished indisputable evidence that the rooms had been occupied. It is quite likely that there were thousands of rooms in the tenement districts of Rome that were no higher than this Pompeiian tenement, and, indeed, more than one Roman poet alludes to the lodgings into which he must "creep," the word, perhaps, indicating not a figurative but a literal method of entrance. That the tenement houses of Rome towered at least 100 feet above the street in front and probably 125 to 130 feet in the rear is certain, for the promulgation of an edict limiting the height to 60 feet in front indicates that this height had been so greatly exceeded in so many cases that the public safety was believed to be imperiled. How many stories were contained in these tenements is conjectural, but if the upper stories were no higher than that of the house in Pompeii, the Roman tenements may have contained as many or more stories than the modern office building.

The height of these Roman buildings was entirely irrespective of the width of the street. Modern building laws have more or less reference to the width of the streets on which the building faces and to the isolation of the structure or its proximity to other buildings. The Berlin building act admits in residence buildings a maximum height of 36 feet, if the street is of that width, and a greater height if the street is broader; the building act of Vienna allows 45 feet if the street is that wide, while the building laws of Paris permit a height in residence buildings of 63¼ feet, provided the street is of that width. The Roman building law, however, had no reference whatever to the width of the street, and as most of the Roman streets were very narrow, the city, looked at from a height, strongly resembled a mass of houses with narrow trenches between. Many important thoroughfares did not exceed 10 feet in width; the widest streets in Rome were not more than 100 feet, while the side streets were often mere passageways from 5 to 6 feet in width. With streets no wider than this, and with houses of which the upper stories projected farther than the lower, it was quite possible for the inhabitants of the topmost tenements to shake hands across the streets, if the custom of shaking hands had been as much in vogue then as now. That the situation was greatly to the advantage of thieves, marauders, and night prowlers is evident from the frequent allusions to the depredations of burglars and the ease with which a passage could be effected from roof to roof, even across the street. While providing an escape for nighthawks, the narrow streets proved also the salvation of tenement residents in case of fire.

A city in which the houses were so closely packed together was extremely liable to extensive conflagrations, but when a tenement house took fire below, the population simply climbed the stairs to the roof and, with such of their goods and chattels as could be easily transported, escaped to the roofs of adjoining tenements or across the streets to houses not affected by the conflagration.

The extreme height and overhanging stories of the Roman buildings were a source of danger to the citizens in more ways than one. There were many important thoroughfares in Rome that were always in the shade; only at high noon did a streak of sunlight find its way between the buildings to the pavement. The streets were thus always damp, for, although Rome was sewered and there was a penalty against throwing slops into the street, the city was none too cleanly, and there were frequent humorous allusions among the poets and writers of odds and ends to the misfortunes sustained by pedestrians, who, while passing along the street, were deluged by buckets of slops carelessly thrown from upper windows.

Pliny mentions a wedding which ended in a riot on account of the leading participants being thus besprinkled with filth—not of design, but through the carelessness of a housewife who lived in the eighth or tenth story and had no desire to work overtime in walking up and down stairs with her bucket. The narrowness and dirtiness of the streets explain the frequent visits of various forms of pestilence, which, from time to time, devastated the city; the black death, the plague, the mysterious visitations of unknown diseases, which, from their symptoms, seem to have been akin to cholera, yellow fever, and diphtheria—all these were indirectly chargeable to the high buildings and the damp streets.

There was another danger hardly less serious. Queer as it may seem to us in these days of gas and electricity, the streets of a city which certainly contained 2,000,000, and may have had 4,000,000 of population, were at night in the darkness of Egypt. Such a state of things presented singular facilities for the operations of footpads and highwaymen, and the frequency with which their operations were attended by murder is shown by the numerous epitaphs that have been discovered intimating that he whose ashes lay beneath was killed by robbers.

Every householder, every tenant in a tenement house, had to look after his own security, and, accordingly, the doors of residences at dark were barred, every window was secured by a strong iron lattice, and in tenement houses the street doors were fastened and a common fund, raised by the tenants, was provided to secure the services of a watchman to look after the building. In the tenement structures which had a respectable class of tenants the watchman went his rounds through the building at regular intervals, but in the better class of houses there were generally two or more watchmen, and the one at the front door was chained, so that he at least would give proper attention to business through the night.

Little heed seems to have been paid by the Roman builders to the edict of Augustus, and from all accounts the houses in the tenement district rose higher and higher, for in the next forty or fifty years half a dozen edicts were promulgated on the subject, which would not have been the case had the first been obeyed. Nero did more for Rome than any monarch before or after his day.

Nero has probably been the most abused individual of ancient times, and his wanton cruelties, the barbarity with which he persecuted not only the Christians, but all opponents, political or religious, his nameless vices, the murders of his relatives, chargeable to his account—all have combined to render him an object of detestation to succeeding ages. But, probably on the principle of "giving the devil his due," Prof. Lanciani has shown that the merit of remodeling Rome was due to this monster in human form. If Lanciani is to be believed, the great conflagration which destroyed Rome in A. D. 64 was the work of Nero's agents, and if the latest researches are to be credited, the work was done with such effectiveness that of the fourteen wards three were completely burned, seven were almost totally destroyed, and the other four were more or less damaged. There seems, however, to have been method in the madness of the emperor, for some historians assert that in spite of the extent of the conflagration, not a single life was lost, while others, admitting there were casualties, declare them to be very few.

However this may have been, it is certain that as soon as the ruins had grown cold the entire working population of the city was given employment in clearing off the débris, transporting it to the Tiber, and erecting new structures. The imperial architects went to work and reconstructed the entire plan of the city. Without paying the slightest regard to previous lines, new structures were laid out as nearly straight as the nature of the ground would permit. Public squares, breathing spots, were located at convenient places in the tenement district, and a law was promulgated that no residence house should be higher than twice the width of the street. This seems to be the first reference among the Roman building laws to any proportion between the height of the house and the street. The changes proposed by Nero, had they all been carried out, would have made Rome a city which, for comfort, convenience, and safety, was unequaled in ancient times and not easily surpassed by modern cities. Every tenement house or residence building was to be isolated from its neighbors; wooden ceilings in the two or three lower stories were prohibited, the ceilings rested on stone or brick arches, wood being permitted only in the upper stories. Every householder was ordered to erect a wooden portico in front of his building, that passers-by might have shelter from sun and rain, while the width of the streets and the isolation of the buildings furnished a reasonable guarantee against future extensive disasters by fire.

Very soon after the promulgation of this law Nero left Rome on his musical tour of Greece and the provinces, and his death in A. D. 68 put an end to the reforms which he projected. They were partially carried out, but his memory was so detestable to the Romans that even the excellent plans which his architects drew up for the reconstruction of the city were thrown aside because they were connected with the name of the most hateful tyrant who had ever occupied the throne of Rome.

The old abuses returned, public squares were sold to speculators, tall tenements with narrow streets again came into fashion, and such was the height of the buildings that one Roman poet mentions a friend who had to climb two hundred steps every night to get to his lodgings, while another alludes to a fire in a tenement which had reached the third story before the dwellers in the upper portions of the building became aware of its presence.

The next building law in Rome was promulgated by Trajan, and without respect to the width of the street. It forbade a height in new buildings of more than 70 feet on the street front, like the other building laws, making no allusion to the rear stories. The tenement evil in Rome was thus on the increase, and an explanation is found in the fact that in those days men were obliged to live close to their work. There was no rapid transportation which enabled the workman to live miles from the factory and to travel back and forth to his home morning and evening. The workman must live within an easy walk of the place of his toil, so the tenement districts of Rome were all located in the manufacturing quarters, and, to state the case in a modern way, all the tenement region of Rome was one vast sweat shop.

Rome was not the only ancient city with building laws; Constantinople had them also. When the Emperor Constantine determined to erect his capital on the Golden Horn, the peninsula was separated from the mainland by a wall, and thus the limits of the city were defined by the imperial orders, so that all might understand whether city taxes or country taxes were to be paid on property in the vicinity, for the difference between urban and suburban real estate was then as closely defined as now. As soon as the emperor's intention became known there was a rush of speculators from all parts of the empire to purchase property in Constantinople and vicinity, and within a year after the imperial proclamation setting apart the peninsula as the chief city the property had gone up 300 per cent. All the real estate within the wall which Constantine had erected as the limit of the capital was held by speculators and capitalists, who invested, hoping to realize a very large profit. Their expectations were not disappointed, but the change of capital from Rome to the East produced a result which was not anticipated.

The price of land rose so high that sufficient rentals could not be realized from the buildings already standing, and capitalists sent to Rome for architects to erect tenement buildings. They came, and if any judgment can be formed from the results of their labors, they must have come in considerable numbers, for in less than ten years after the announcement of Constantinople as the capital city the tenements of Byzantium rivaled the tenements of Rome. Constantine had fixed upon the top of the hill, the highest point of the peninsula, for his palace, but, to the intense disgust of the royal occupant, it was discovered that before the splendid residence of the emperor was fairly finished his view of the sea was cut off by the innumerable tenements, which, standing on much lower ground, still rose high enough to impair the prospect from the royal palace.

Constantine was not the man to put up with this sort of thing. He had spent too much money on his house to move, so a building edict was promulgated forbidding any tenement higher than 100 feet to be constructed, and also ordering those which exceeded that height to be reduced to the proper limit. Great was the outcry among investors and speculators, for it is said that from one block of buildings four stories had to come down. How high these stories were we have no means of knowing, but, supposing them to have been only 9 feet, there must have been tenement buildings in Constantinople that exceeded 136 feet in height. Various emperors, after Constantine, endeavored to restriet the construction of high buildings, in order to retain a view of the sea from the imperial residence, but all in vain; the architects persisted in carrying the houses up to the legal limit, and whenever it was possible to disregard the statute it was disobeyed.

One curious case is recorded of evasion, showing that men in those days were as sharp as they are now in ignoring the spirit, while pretending to comply with the letter, of the law. Apothagos, a Constantinopolitan, erected a row of tenements about half way between the Golden Horn and the royal palace. The houses were of stone and brick up to the legal limit of 100 feet; above this there was erected a shanty structure of wood, three stories in height. The imperial building commissioners objected and ordered Apothagos to ipull down his superstructure, but he refused, alleging that the law applied to permanent, not to temporary buildings; that the wooden superstructure was only temporary, designed for the use of his workmen until the interior of the house should have been fully completed. The commissioners persisted in their order for the removal of the wooden stories, when the stubborn Apothagos went to law and applied to the imperial court for a writ commanding the commissioners to abstain from disturbing his peace and damaging his property. Law then was what it is now, and as Apothagos secured good lawyers to plead his case, on one technicality or another the matter was kept in litigation for years, meantime the structure continuing an eyesore to the emperor and court. The matter was finally decided by the courts, ten years after litigation had begun, and Apothagos was ordered to remove his wooden structure. But in the interval Emperor Leo II. died, and his successor, paying little attention to such matters, and the building law having been disregarded in many quarters, the wily Apothagos obeyed by tearing down the wooden stories and putting a brick and stone superstructure in their stead.

The Emperor Zeno, directly after his accession, in A. D. 474, undertook to reform the Constantinople buildings, and promulgated a building edict limiting all future tenement structures to 100 feet in height, provided the street in front was 100 feet wide. Constantinople then suffered as much from fire as it has done under the rule of the Turks, and it was after one of these great periodic conflagrations that the reform of Zeno was begun. The burned district lay to the north of the peninsula, and Zeno's architects, following the example set by Nero, disregarded all former streets and boundaries, and laid out new avenues, straight from the top of the hill to the water, crossed at right angles by streets running parallel with the shore. The streets from the hill to the water were 100 feet in width, while the avenues crossing them were 60 feet, and just in front of the imperial palace a grand avenue 150 feet in width, leading straight to the water from the central palace gate, was projected. This portion of Constantinople was thus made regular, and it is the only part of the city that now has wide streets and avenues, crossing at right angles, for ere Zeno could carry out his plan for rebuilding the entire city he died, and the scheme was given up by his successors.

There is abundant evidence that high buildings, or at least buildings of a height that the ancients were not supposed capable of reaching, were to be found in almost every large city of antiquity. It is said by Herodotus that there were houses in Babylon of four stories in height, while the Carthage houses often exceeded six stories. The city of Tyre was limited to an island where the circumscribed area made property expensive, and consequently high houses were the rule at Tyre, as in Constantinople and Rome. Houses of ten stories were mentioned by several Greek historians as being numerous in Tyre and other seaside cities of the East. We know that the tenement houses of Jerusalem must have been very high buildings, as eight and ten stories are mentioned, and one rabbi speaks of having to climb over 100 feet in the air before he could reach his room. Athens had a building law limiting the height of structures for residence purposes to ten stories, though the height of these stories is not mentioned.

The walled cities of the middle ages rendered land valuable for building, and, consequently, to secure proper returns, capitalists were forced to erect high structures. On the other hand, therefore, the legal authorities were obliged to enact building laws to prevent these buildings being so lofty as to endanger the pub-

lic safety. The islands on which Venice was built were limited in area, and property was very valuable, so much so, in fact, that the council was compelled to pass a building law limiting the height of buildings to 70 feet. In Florence, so long as the city was confined by walls, the limit was 100 feet; in Paris, 60; in Toledo, 75 feet. Rheims had a curious building law, forbidding any structure for residence purposes to be erected higher than the eaves of the cathedral, and it is recorded that whenever a building was going up the sexton was enjoined to look out daily from the portholes in the eaves and see that the walls of no structure rose higher than the level of his eyes. The burghers of Amsterdam probably borrowed the idea from the council of Rheims, and ordered that no tenement or residence house should be higher than the third story of the Rathhaus, this building being the pride of the city, being thus jealously preserved in its pre-eminence over all others.

The building laws of both ancient, medieval, and modern times have not generally applied to structures other than residences and office property, and it is marvelous to what an extent the architects of ancient and medieval days succeeded in rearing strong, stable, and lofty buildings. The Birs Nimroud, or Tower of Babel, now only a mound, has been partially excavated, and from the portions that have been uncovered it is estimated that this tower or temple must have had sixty stories and been from 500 to 800 feet in height. The Pyramids of Egypt, among the earliest human monuments, are also the most stupendous. The base of the Great Pyramid covers thirteen acres of ground, and the height is slightly above 500 feet. In other words, the great pyramid of Cheops is almost exactly the dimensions of Pilot Knob, in the southern part of Missouri, and this huge pile is of solid cut stone throughout. Giant structures are not confined to Egypt or Europe, for the temples in India rival, in extent and magnificence, those of the most cultured nations of the West. Nor has even the Old World a monopoly of tall buildings, for the Mexican pyramids, erected at an unknown period, rival, in size and dimensions, the second-class pyramids of Egypt.

In comfort and convenience no dwellings of any age can compare with those of our own day, but so far as solidity of construction is concerned, the ancients built as substantially as the moderns, and in even the great tenement buildings of Rome, Constantinople, Tyre, and Jerusalem the quality of the materials employed and the close inspection of government officials rendered these structures so substantial that the falling of a house from any cause, save by fire, was a comparatively rare occurrence.—St. Louis Globe-Democrat.

ORNAMENTAL CHIMNEY PIECE BY JEAN BAFFIER.

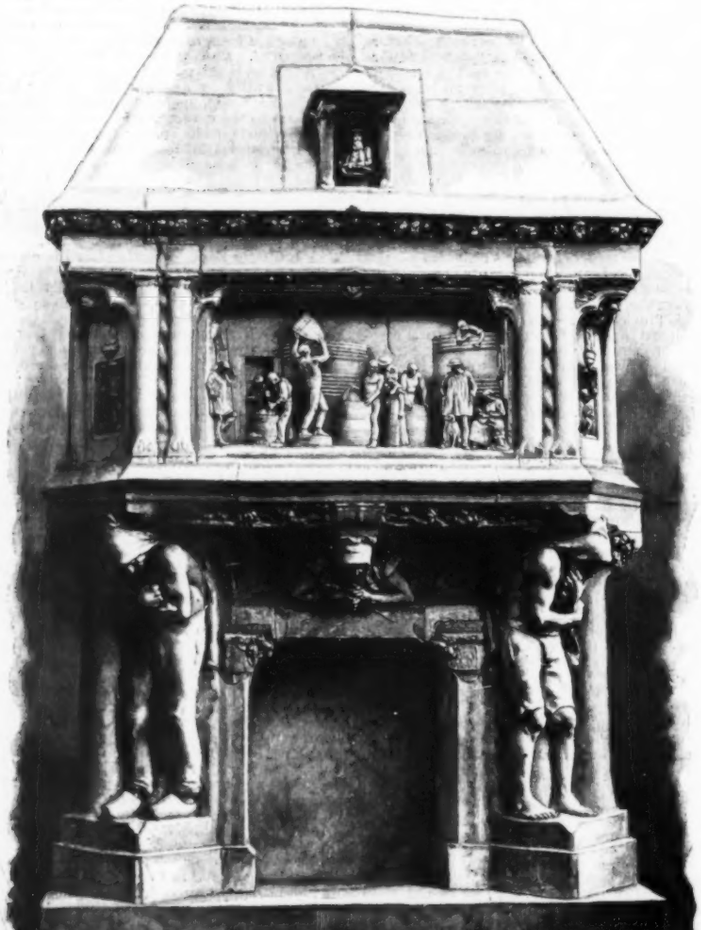
In contemporaneous sculpture Jean Baffier has acquired a place apart through a stubborn and happy pursuit of the poetry inherent to the soul of beings and to simple things.

It would be idle to inquire as to what contribution the teachings of the School have offered to his talent. There is nothing to do but take his art as we find it, without concerning ourselves with the processes that have favored the development of it. His inspiration is drawn from the very well-springs of that nature which he loves and understands so well in its exact manifestations, and of which he combines the most humble forms in a harmony of movement and lines that gives to everything that he reproduces a striking expression of truth and life.

The ornamental mantel piece by him that may be admired at the Salon of this year under the title of "La Vin" (Wine) is a striking example of the art of Jean Baffier, who is voluntarily ignorant of all the allegorical forms used in ornamentation, and who is anxious to offer to the simplest minds a faithful reproduction of the familiar scenes of their life. Everything is living and borrowed from the rustic life of today in those episodes of the manufacture of wine which he has desired to represent in his monumental chimney piece—from the two vine dressers of mature age bent as caryatides under the ornate mantel of foliage of which they support the weight to the industrious vintagers around the vats, and to the head vine dresser attentive with his family in superintending the important work of preparing wine.

There is nothing, up to the hurdy-gurdy player standing at the high dormer window, that does not concur in depicting the domestic joys that will be introduced by the wine, either by enlivening, with its primitive music, coming nuptials at which it will be drunk immoderately, or by lending a rhythm to the dances for which its generous ardor will give a desire to the lads and lasses of the farm during the long vigils of winter.

The very details of construction of the chimney piece are borrowed from the productions of the country for which it is visibly designed. These are tree trunks, which form the columns of it, and of which the foliage serves as a capital thereto before spreading out in a graceful garland under the cornices that sustain the two harmoniously distributed parts. This work, as a whole, leaves a deep impression of poetry borrowed from rustic life itself. So this very realistic and very modern work has something of an antique savor because it ennobles the most vulgar objects, just as was done by the greatest artists of ancient times. Baffier takes his motives of ornamentation from the nature that surrounds him, just as the ancients did with the motives of their invention which have since been so servilely imitated.—Le Magasin Pittoresque.



ORNAMENTAL CHIMNEY PIECE BY JEAN BAFFIER.

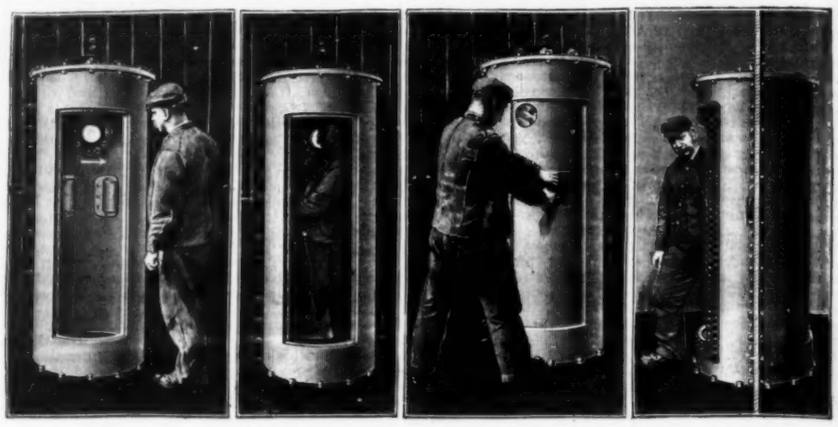


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

METHOD OF MANEUVERING THE KIRKALDY BULKHEAD DOOR.

A NEW BULKHEAD DOOR.

From the viewpoint of safety of transportation, the partitioning of ships by means of bulkheads is very important. Theoretically, at least, tight bulkheads divide the ship into a certain number of sections, each capable of floating by itself, and the capacity of which is so calculated that the floatability of the ship, considered in its entirety, shall remain adequate when, through a collision or any other cause, one or more of the compartments are penetrated by water.

Unfortunately, this is merely theory, and what well proves it are the catastrophes that have occasionally occurred, such as that to the "Drummond Castle," which disappeared in a few minutes because a part of her hull was split open upon the rocks, and that to the English armorclad "Victoria," which sank almost head foremost because, in a maneuver, the "Camperdown" stove a hole in her side with her prow. It might be concluded from this that tight bulkheads are not as efficient as they are supposed to be, or at least that they are incapable of resisting the thrust of the water that enters a compartment. The true reason, however, is that they are provided with doors, and that the latter never happen to be closed at the critical moment, and consequently annihilate the effect of the bulkheads. It will be readily understood why it is necessary to form a door in the bulkhead that separates two compartments. Without that these walls, which ascend at least to the load water line, would prevent a direct passage from one part of the vessel to the other, and in a passenger ship, for example, one would, in order to go from one cabin to another, be obliged to ascend a stairway to the top of the bulkhead and then descend on the other side.

With a door, such complication ceases; but, at the moment of an accident, it is absolutely necessary that all the doors shall, so to speak, be instantaneously closed. It is evident that such a condition will never be fulfilled if the closing of each door is to be effected separately and by a mechanism placed in the interior of the compartments; for, in the excitement of a collision or of an influx of water, a person has neither the coolness nor the time to go below and perform these successive maneuvers. In order to surmount this difficulty, an endeavor has been made to control the simultaneous motion of the different doors by electric or hydraulic methods; but this would not be unattended with grave danger in case some one should be passing through a doorway at the moment in which the door was thus closing automatically. Upon certain ships doorless bulkheads have been adopted; but this does not solve the problem. It seems to us that the solution has just been found by Mr. William Kirkaldy (an engineer of Glasgow), in the form of a rotary, cylindrical door, of which we give several figures in order to show its construction and operation. Let us remark at once that in three of these figures the door is mounted in situ upon a bulkhead, but that in the fourth it is isolated so that the two sides of it may be seen simultaneously.

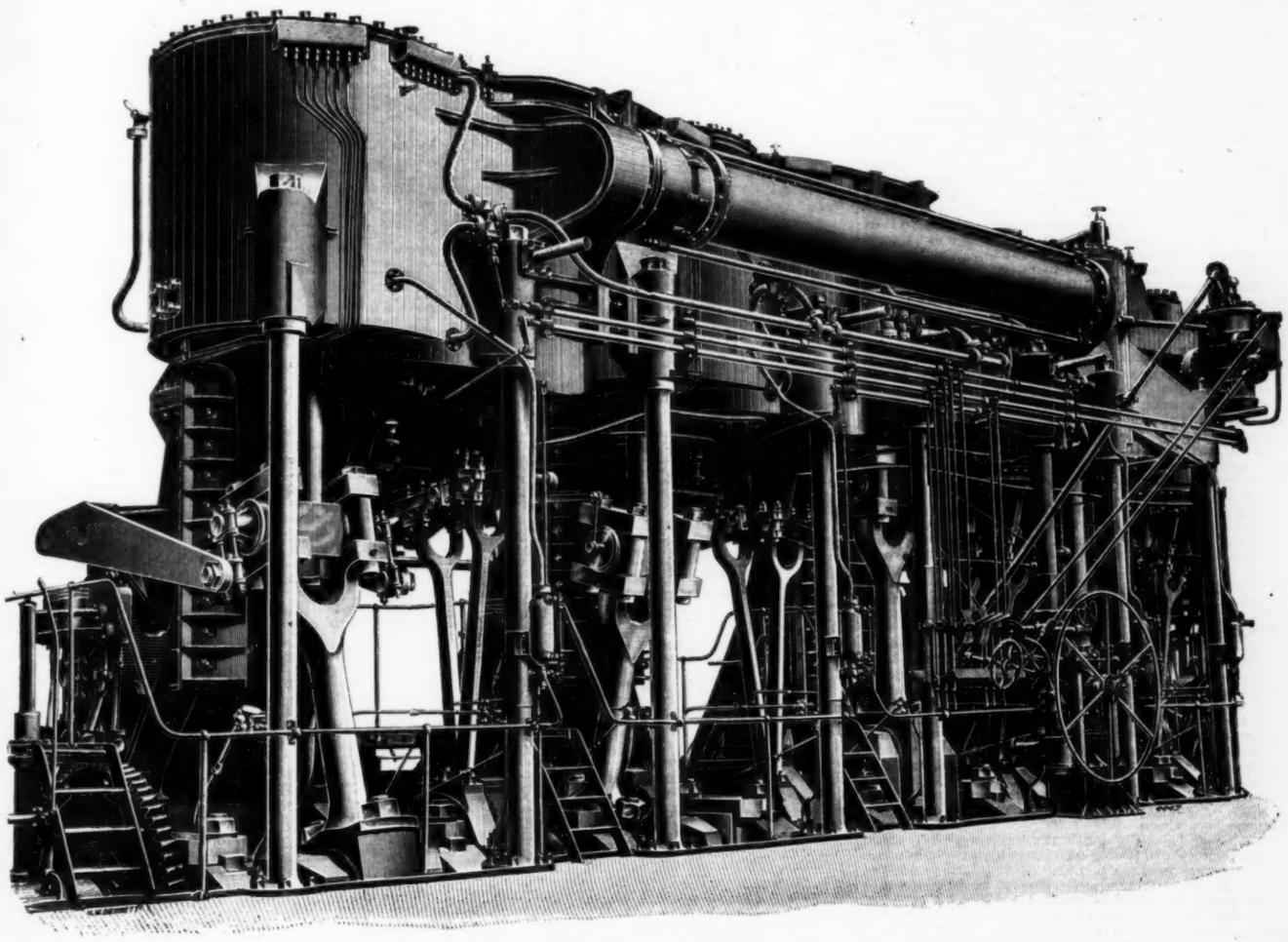
Mr. Kirkaldy's invention comprises a hollow metallic cylinder closed at the top and bottom by firmly bolted plates. This cylinder is fixed to the bulkhead by a metallic frame arranged in its center and in the direction of one of its generatrices. Moreover, it is provided with two rectangular openings that face each other.

In the interior, accurately fitting and carefully balanced, there is a second cylinder, which is capable of revolving upon a central axis provided with ball bearings, and which presents but a single rectangular aperture of exactly the same dimensions as those of the stationary cylinder. This internal cylinder, which is shown in Fig. 1, really constitutes the revolving door that moves in the direction shown by the arrow.

It will be seen that this door can never be left open, and that it nevertheless affords an easy passage to those that have occasion to go through the tight bulkhead. The person who wishes to go from one compartment to the other first peeps through the little window to see if there is anyone on the other side to obstruct his passage, and if the apparatus is in the position shown in Fig. 1, he enters the cylinder (Fig. 2) and the latter is then revolved from left to right. The aperture through which he has entered is covered by the wall of the cylinder, and the opposite opening is soon completely uncovered. He can then make his exit. When, on the contrary, the door presents itself as shown in Fig. 3, the motion indicated in the latter is effected, and this brings the cylinder back to the position shown in Fig. 1, and one passes as before in order to make his exit, as shown in Fig. 4.

Upon the whole, the door is always open and always closed (although this statement appears somewhat paradoxical), and thus, while affording a passageway from one compartment to another, offers perfect security in case of accident. The apparatus is a true air lock, and this is again an advantage, especially for stokeholds, since the entrance of strong back draughts are rendered impossible. Finally, it takes but five seconds at the most to pass through a door of this kind.

For the above particulars and the illustrations we are indebted to La Nature.



ENGINES OF H. M. S. "EUROPA."

THE ENGINES AND BOILERS OF H. M. S. "EUROPA."

H. M. S. "Europa," a first-class protected cruiser of 11,000 tons, built by the Clydebank Shipbuilding and Engineering Company, Limited, Clydebank, has just run her official steam trials in the English Channel, and we annex an engraving of the main propelling engines. The ship belongs to the "Diadem" class, of which eight have been ordered. She is 435 feet long, 69 feet 6 inches extreme breadth, and at 25 feet 3 inches draught displaces 11,000 tons. She has a protective deck right fore and aft, and her guns are all protected. Her armament includes sixteen 6-inch quick-firing guns; fourteen 12-pounder quick-firing guns; three 3-pounder quick-firing guns; eight machine guns; and two submerged torpedo-launching tubes. The main engines are of the four-cylinder triple-expansion type. Each of the two sets is designed to develop 8,250 indicated horse power, giving a combined indicated horse power of 16,500. Steam is supplied by water tube boilers of the Belleville type. The safety valves on the boilers are loaded to a pressure of 300 pounds per square inch, this pressure being reduced to 250 pounds at the engines by means of a reducing valve placed at the forward end of each engine room. Each set of engines is placed in a separate engine room, divided by a longitudinal water-tight bulkhead, which extends the whole length of the machinery space, and each engine room is, in all respects, exactly similar, and entirely independent of the other.

The diameters of the high and intermediate pressure cylinders are 34 inches and 55½ inches respectively, while the diameter of each of the low pressure cylinders is 64 inches, all having a stroke of 4 feet. The high and intermediate pressure cylinders are fitted with piston valves of the inside type, having approved adjustable packing rings, while the low pressure cylinders are fitted with treble-ported flat slide valves on their sides, having a special type of relief frame to remove the steam pressure, and the weight of all valves is suitably balanced in order to reduce the strain on the valve gear as far as possible. The cylinders, which are entirely independent castings, are bolted together to provide sufficient longitudinal stiffness; and to further increase their stability in the event of ramming, etc., strong struts are fitted between the high pressure cylinder and the forward structure of the vessel, as well as transversely between the respective cylinders in each engine room. The barrels of all the cylinders are made of special close-grained cast iron, and are steam jacketed. The valve gear is of the double eccentric link motion type, and is moved by means of a double cylinder engine attached to one of the intermediate front columns at the level of the starting platform and beside the starting handles. Each of the reversing levers is provided with screw gear, so that the valves of each cylinder may be linked up independently.

The pistons, cylinder covers, and steam chest doors are of cast steel. The piston and connecting rods are of Siemens-Martin steel, and metallic packing has been employed for all the stuffing box glands of the piston rods and valve spindles of the main engines, as well as for all of the auxiliary engines throughout the vessel. The crankshafts are hollow, and each consists of two interchangeable pieces 17½ inches in diameter at the journals and 9 inches in internal diameter; the crank arms are cut away as much as possible for lightness; the thrust shaft and propeller shafting are also hollow, the shafting being 16¼ inches in diameter inboard and 17½ inches in diameter outside the ship. The propellers are three-bladed, working inward, and are 17 feet 6 inches in diameter. The bosses are of gun metal, and the blades are of manganese bronze, this material permitting a considerable reduction of section to be made on account of its superior strength in comparison with gun metal for such purposes, and consequently a corresponding increase of the efficiency of the propellers is anticipated. The blades are secured to the bosses by large forged naval bronze pins. Tail pieces and guards for preventing eddies either forward or aft of the propeller have been fitted in accordance with the usual Admiralty practice.

The condensers are of cast brass, having a total cooling surface of 17,500 square feet. The steam is condensed outside the tubes, which are ⅝ inch in external diameter by 0·5 inch thick, the circulating water passing through them. The water is supplied by four large Allen's circulating pumps, each being driven by an independent engine. Each pump is large enough to supply sufficient condensing water for full power working. The pumps with steam of 200 pounds pressure are each capable of discharging per hour 1,200 tons of water from the bilge. The engines driving them may exhaust into the atmosphere, and work at a speed of 300 revolutions per minute. The exhaust steam from the whole of the auxiliary machinery in the ship is led into the auxiliary exhaust pipes, which are connected both with the atmosphere by the auxiliary exhaust pipe carried up the funnel and with the respective auxiliary condensers in either engine room. Each of these condensers has its own air and auxiliary circulating pump, entirely independent of those for the main condenser, and these are driven by independent engines. The combined cooling surface of these two auxiliary condensers is 2,200 square feet, and their tube casings, like those of the main condenser, are of cast brass. Messrs. W. H. Allen & Company supplied the pumping machinery in connection with them.

Besides the auxiliary engine already noticed, a double cylinder turning engine is conveniently placed above the starting platform on one of the aft columns which support each of the aft low pressure cylinders, for the purpose of turning the engines. This is effected by a set of compound worm gearing, the wormwheels having machine-cut gun metal teeth, the main worms being of manganese bronze. These engines are capable of turning the main engines completely round in eight minutes with a steam pressure of 200 pounds, and a hand gear has also been arranged for the same purpose.

In the "Europa" there are in all thirty Belleville boilers, of the economizer type, in four separate water-tight compartments. In each of the after and second aft boiler rooms there are eight boilers of eight elements, each boiler having an economizer of six elements. In the second forward boiler room there are two boilers of eight elements and six boilers of seven elements, and, as in the after boiler room, each has an economizer of six elements. In the forward boiler room there are four boilers of nine elements, and two boilers of eight elements; the nine-element boilers have economizers of seven elements and the two eight-element boilers have six elements economizers. Each boiler element consists of seven pairs of tubes screwed in junction boxes of malleable cast iron. The tubes are 4⅛ inches in external diameter, and are of cold, solid drawn steel. The economizer elements are similar to the main elements, with the exception that the tubes are 2¾ inches in diameter. The heating surface of the boilers is 29,620 square feet, and the economizers have a surface of 10,980 square feet, making a total heating surface of 40,600 square feet, and the grate surface is 1,450 square feet.

The feed arrangements for supplying the boilers have

been most carefully worked out, and every precaution has been taken to insure the efficiency of the system against any contingency. The arrangement comprises a main and auxiliary system of pumps and pipes, which are separate and independent of each other. The main feed system consists of four double acting pumps made by Messrs. G. & J. Weir, one being placed in each boiler room. These pumps draw by independent pipes from the feed tanks and deliver by branch pipes to the feed regulators attached to the boilers. The four pumps of the auxiliary feed system, likewise of Weir's manufacture, are placed one in each compartment. These auxiliary pumps are also connected to the main feed tanks by independent pipes, and in addition have separate connections to the reserve fresh water tanks and the sea, and each discharges to the feed regulators in connection with the boilers. The main steam supply is conveyed by four lines of steel steam pipes, two lines being arranged on each side of the ship, and these are each entirely independent of the other, as are also the connecting pipes from the boilers of each of these lines. Any boiler may, therefore, be cut off from the system without interfering with the performance of the others in the compartment, as may also any compartment from which one of these main steam pipes lead without affecting the efficiency of the other compartment. Any group of boilers may supply steam to any of the engines.

The "Europa" then proceeded on the first 30 hours' official trial. Everything worked satisfactorily from start to finish. The mean results attained were 3,302 indicated horse power, the mean revolutions being 65·4 per minute, while the coal consumption was 2·2 pounds per indicated horse power per hour. The "Europa" was run four times over the measured mile at Stokes Bay at the top of the tide on June 1, to determine the speed for the 3,300 indicated horse power, which gave a mean speed of 12·76 knots.

On Friday forenoon, June 3, she commenced her second 30 hours' trial. It was at 12,510 indicated horse power, or 75 per cent. of the full power, and, according to the design, this result should, without effort, be maintained under any condition as long as there is coal in the bunker. Thirty hours is a sufficiently long time for any defect to discover itself; so that the "Europa" having passed through the ordeal for that period, there is every confidence in anticipating that she can do it as long as her coal lasts. Throughout the 30 hours everything worked satisfactorily, and the mean power was 13,739, with a mean of 103·8 revolutions. The speed of the ship, tested over the Admiralty measured course of 23 sea miles or so outside Plymouth Sound, was 19½ knots; so that in the 30 hours the "Europa" traveled some 600 sea miles, and during that time the coal consumption was at the rate of 1·8 lb. per indicated horse power per hour. As usual, hourly records were taken of the performance of the engines throughout the 30 hours' trial.

The final results, as made up at the close of the trial, showed that the main boiler pressure was 265 pounds per square inch, and here it may be said that all the thirty steam generators were used. The steam pressure was reduced to 250 pounds at the engines by the usual valves. The links were set for a cut-off equal to about 49 per cent. of the stroke, and they were scarcely ever touched during the progress of the long trial. The mean revolutions of the starboard engine were 103·9 per minute, showing a mean of 6,485 indicated horse power; while the port engine ran at 103·7 revolutions, showing a mean of 6,254 indicated horse power. In the case of the starboard engine the high pressure cylinder indicated 2,151 horse power; intermediate, 1,927 horse power; the one low pressure 1,184 horse power, the other 1,223 horse power; while in the case of the port engine the high pressure cylinder contributed 2,022 horse power; intermediate, 1,819 horse power; one low pressure 1,194 horse power, and the other 1,219 horse power. The vacuum in the case of the starboard engine was 25 inches, and in the case of the port engine 25½ inches. The mean collective power for both engines was thus 12,735 indicated horse power, with 103·8 mean revolutions. During the trials there were on board Mr. J. G. Dunlop, on behalf of the Clydebank firm; Mr. Butler for the Admiralty; Mr. G. T. Corner, for the Portsmouth Dockyard; and Mr. W. H. White, Portsmouth Reserve.

After coaling at Plymouth the "Europa" left again for an 8 hours' full power trial, in which she made two runs over the deep sea course. She had 279 pounds of steam in her boilers, and with 113 revolutions and 17,137 indicated horse power she achieved a speed of 20·4 knots, but the mean of the eight hours gave a collective indicated horse power of 17,010. The "Diadem" at the corresponding trial, with 17,188 indicated horse power, gave a speed of 20·6 knots on the deep sea course. The "Europa" had just completed her trial, and was off Torquay, when a thick fog fell, and she had to remain for several hours. During the night, however, the fog lifted, and she returned to Spithead.

For our engravings and the foregoing particulars we are indebted to Engineering.

THE PRESENT STATUS OF THE UNITED STATES NAVY.

THE Navy Department has just issued a very instructive pamphlet, dated July 1, which gives the list and stations of the officers as well as the full list of all of the vessels in the navy, including those which are building and those which have been acquired. As we have already given in our NAVY SUPPLEMENT full particulars as to the regular vessels of the navy, we need not repeat them here; the tables annexed will be found useful, however, for the auxiliary cruisers, steamers, etc., and the vessels under construction. An examination of the tables shows that we have at present 301 vessels, of which 236 are available for war purposes, the rest being unserviceable or under construction. The "Registry of the Navy of the United States," which was published on January 1, 1898, listed only 141 vessels, of which 109 were available for service, so that in the few months which have intervened between the destruction of the battleship "Maine" we have built and acquired by purchase 126 vessels, and during the same period we have only lost one—the battleship "Maine." At present, the United States navy has 11 ships which are classed as "first rate," which includes all the battleships, the two armored cruisers,

CRUISERS AND YACHTS.

No.	Name.	Displacement (tons).	Type.	Hull.	I. H. P.	Propulsion.	Guns.	Station.
403	Aileen	*c* 289	Yacht	S.	500	S. S.	*b* 5	Auxiliary Naval Force.
413	Badger	.....	Cruiser	.....	.....	.....	*a* 6	North Atlantic Fleet.
417	Buffalo	7,500	....do	S.	.....	S.	*a* 10	Unassigned.
434	Dixie	7,500	....do	S.	3,800	S.	*a* 10	Eastern Squadron.
435	Dorothea	304	Yacht	S.	.....	S. S.	*b* 10	North Atlantic Fleet.
440	Eagle	492	....do	S.	.....	S. S.	*b* 6	Do.
443	Elfrida	*c* 173	....do	S.	.....	S. S.	*b* 1	Auxiliary Naval Force.
442	Enquirer	136	....do	S.	.....	S. S.	*b* 2	Auxiliary Naval Force.
446	Free Lance	*c* 192	....do	S.	.....	S. S.	*b* 2	Do.
449	Frolic	566	....do	S.	.....	S. S.	*b* 4	North Atlantic Fleet.
453	Gloucester	786	....do	S.	2,000	S. S.	*b* 10	Do.
461	Harvard	11,550	Cruiser	S.	14,500	S.	*a* 8	Special.
463	Hawk	545	Yacht	S.	1,000	S. S.	*b* 4	North Atlantic Fleet.
469	Hist	*c* 494	....do	S.	.....	S. S.	*b* 6	Do.
471	Hornet	494	....do	S.	950	S. S.	*b* 7	Do.
472	Huntress	*c* 185	....do	Comp.	.....	S. S.	*b* 3	Auxiliary Naval Force.
480	Kanawah	*c* 175	....do	Comp.	.....	S. S.	.....	Do.
477	Inca	.....	....do	.....	.....	.....	.....	Do.
518	Oneida	*c* 373	....do	S.	.....	S. S.	*b* 4	North Atlantic Fleet.
523	Panther	.....	Cruiser	.....	.....	.....	*b* 2	Unassigned.
527	Peoria	625	....do	S.	.....	S. S.	*b* 7	North Atlantic Fleet.
537	Prairie	7,500	....do	S.	.....	S.	*a* 10	Do.
539	Restless	*c* 194	Yacht	I.	500	S. S.	*b* 4	Auxiliary Naval Force.
546	Scorpion	850	....do	S.	2,800	T. S.	*a* 4	North Atlantic Fleet.
.....	Shearwater	.....	....do	.....	.....	.....	.....	Auxiliary Naval Force.
561	Siren	*c* 315	....do	.....	.....	S. S.	*b* 1	North Atlantic Fleet.
556	St. Louis	16,000	Cruiser	S.	18,000	S.	*a* 8	Special.
557	St. Paul	16,000	....do	S.	18,000	S.	*a* 6	Do.
558	Stranger	*c* 548	Yacht	I.	.....	S. S.	*b* 5	North Atlantic Fleet.
565	Sylph	.....	Yacht	.....	.....	.....	.....	Unassigned.
562	Sylvia	*c* 202	....do	I.	.....	S. S.	*b* 3	North Atlantic Fleet.
576	Viking	*c* 271	....do	I.	.....	S. S.	*b* 4	Do.
578	Vixen	800	....do	S.	.....	S. S.	*b* 8	Do.
580	Wasp	750	....do	S.	1,800	S. S.	*b* 6	Do.
591	Yale	11,350	Cruiser	S.	14,500	S.	*a* 8	Special.
592	Yankee	7,500	....do	S.	3,400	S.	*a* 10	Eastern Squadron.
593	Yankton	*c* 879	Yacht	S.	750	.....	*a* 1	North Atlantic Fleet.
599	Yosemite	7,500	Cruiser	S.	3,362	S.	*a* 10	Eastern Squadron.

a Main battery guns. *b* Secondary battery guns. *c* Estimated.
d Torpedo tubes.

STEAMERS AND COLLIERS.

410	Arctic	.....	.....	.....	.....	.....	*a* 1	Auxiliary Naval Force.
400	Abarenda	*c* 6,782	Collier	.....	1,000	.....	*b* 2	Eastern Squadron.
407	Alexander	*c* 7,492	....do	.....	1,026	S. S.	*b* 2	Do.
415	Brutus	.....	....do	.....	.....	.....	*b* 2	Asiatic Station.
418	Cæsar	*c* 5,834	....do	.....	.....	.....	*b* 2	North Atlantic Fleet.
420	Cassius	.....	....do	.....	.....	.....	*b* 3	Do.
421	Celtic	*c* 8,751	Supply ship	.....	.....	.....	.....	Do.
433	Delmonico	.....	....do	.....	.....	.....	.....	Eastern Squadron.
441	East Boston	.....	Ferryboat	.....	.....	.....	*b* 2	North Atlantic Fleet.
454	Governor Russell	.....	....do	.....	.....	.....	*a* 1	Do.
459	Hannibal	*c* 4,181	Collier	.....	1,100	.....	*b* 2	Do.
.....	Hector	.....	.....	.....	.....	.....	.....	Unassigned.
474	Iris	.....	Steamer	S.	.....	S. S.	.....	North Atlantic Fleet.
479	Justin	*c* 4,857	Collier	S.	.....	S. S.	*b* 2	Do.
481	Lebanon	*c* 3,375	....do	S.	.....	S. S.	*b* 4	Do.
482	Leonidas	*c* 6,034	....do	.....	1,100	S. S.	*b* 2	Do.
492	Marcellus	.....	Steamer	.....	.....	.....	.....	Unassigned.
494	Merrimac	7,500	....do	S.	1,300	S. S.	*b* 2	North Atlantic Fleet.
505	Nanshan	*c* 4,827	....do	.....	.....	.....	.....	Asiatic Station.
509	Naro	4,925	....do	.....	S.	.....	*b* 4	Do.
512	Niagara	*c* 4,640	....do	I.	.....	T. S.	*b* 2	North Atlantic Fleet.
532	Pompey	*c* 2,975	Collier	.....	.....	.....	*b* 2	Do.
.....	Rainbow	.....	Distilling ship	.....	.....	.....	.....	Unassigned.
540	Resolute	*c* 3,712	Transport steamer	S.	.....	S. S.	*b* 2	North Atlantic Fleet
545	Saturn	*c* 5,420	Collier	.....	.....	.....	.....	Do.
547	Scindia	*c* 5,294	....do	.....	.....	.....	*b* 2	Eastern Squadron.
555	Scipio	.....	....do	.....	.....	.....	.....	Unassigned.
550	Solace	6,000 (loaded)	Ambulance ship	S.	.....	.....	.....	North Atlantic Fleet.
551	Southery	*c* 4,729	Collier	S.	.....	.....	*b* 2	Do.
554	Sterling	*c* 2,549	....do	I.	926	T. S.	*b* 2	Do.
559	Supply	.....	Supply ship	.....	.....	.....	.....	Do.
579	Vulcan	*c* 3,543	Steamer	.....	.....	.....	*b* 2	Do.
599	Zafiro	*c* 2,620	Supply ship	S.	213	S. S.	.....	Asiatic Station.

UNDER CONSTRUCTION.

Name.	Displacement (tons).	Type.	Hull.	I. H. P.	Propulsion.	Guns (main battery).	Station or condition.
Kearsarge	11,525	1st class battle ship	S.	10,000	T. S.	22	Building at Newport News Ship Building and Dry Dock Co., Newport News, Va.
Kentucky	11,525	....do	S.	10,000	T. S.	22	
Illinois	11,525	....do	S.	10,000	T. S.	18	
Alabama	11,525	....do	S.	10,000	T. S.	18	Building at Cramp & Sons', Philadelphia.
Wisconsin	11,525	....do	S.	10,000	T. S.	18	Building at Union Iron Works, San Francisco, Cal.
Maine	.....	....do	S.	.....	T. S.	.....	Contract not yet awarded.
Missouri	.....	....do	S.	.....	T. S.	.....	Do.
Ohio	.....	....do	S.	.....	T. S.	.....	Do.
Plunger	168	Submarine torpedo boat.	S.	1,200	T. S.	*d* 2	Building at Columbian Iron Works, and Dry Dock Co., Baltimore, Md., under contract with J. P. Holland Torpedo Boat Co.
Tug No. 6	225	Tug	S.	450	S.	.....	Building at navy-yard, New York.
Tug No. 7	225	....do	S.	450	S.	.....	Building at navy-yard, Mare Island.
Chesapeake	1,175	Sailing ship	Comp.	.....	Sails.	6	Building at Bath Iron Works.
Gunboat No. 16	.....	Gunboat	S.	.....	.....	.....	Contract not yet awarded.
Arkansas	2,700	Monitor	S.	.....	.....	.....	Do.
Connecticut	2,700	....do	S.	.....	.....	.....	Do.
Florida	2,700	....do	S.	.....	.....	.....	Do.
Wyoming	2,700	....do	S.	.....	.....	.....	Do.
Bainbridge	.....	Torpedo-boat destroyer.	S.	.....	.....	.....	Do.
Barry	.....	....do	S.	.....	.....	.....	Do.
Chauncey	.....	....do	S.	.....	.....	.....	Do.
Dale	.....	....do	S.	.....	.....	.....	Do.
Decatur	.....	....do	S.	.....	.....	.....	Do.
Hopkins	.....	....do	S.	.....	.....	.....	Do.
Hull	.....	....do	S.	.....	.....	.....	Do.
Lawrence	.....	....do	S.	.....	.....	.....	Do.
Macdonough	.....	....do	S.	.....	.....	.....	Do.
Paul Jones	.....	....do	S.	.....	.....	.....	Do.
Perry	.....	....do	S.	.....	.....	.....	Do.
Preble	.....	....do	S.	.....	.....	.....	Do.
Stewart	.....	....do	S.	.....	.....	.....	Do.
Truxtun	.....	....do	S.	.....	.....	.....	Do.
Whipple	.....	....do	S.	.....	.....	.....	Do.
Worden	.....	....do	S.	.....	.....	.....	Do.

REVENUE CUTTERS.

405	Algonquin	.....	.....	.....	.....	.....	*b* 2	North Atlantic Fleet.
419	Calumet	174	.....	.....	.....	.....	*b* 2	Do.
428	Corwin	*c* 424	.....	W.	.....	.....	.....	Pacific Station.
455	Grant	*c* 407	.....	I.	.....	S. S.	.....	Do.
456	Gresham	906	.....	S.	.....	S. S.	.....	North Atlantic Fleet.
460	Hamilton	250	.....	I.	.....	S. S.	*a* 1	Do.
473	Hudson	174	.....	S.	524.67	S. S.	*b* 3	Do.
486	Manning	986	.....	Comp.	2,000	S. S.	*a* 3	Do.
490	McCulloch	1,280	.....	Comp.	.....	S. S.	.....	Asiatic Station.
491	McLane	*c* 346	.....	I.	.....	.....	.....	North Atlantic Fleet.
502	Morrill	397	.....	I.	.....	S. S.	*a* 2	Do.
529	Perry	*c* 534	.....	I.	.....	.....	.....	Pacific Station.
543	Rush	*c* 695	.....	.....	.....	.....	.....	Do.
584	Windom	525	.....	S.	800	S. S.	*c* 1	North Atlantic Fleet.
585	Woodbury	370	.....	W.	.....	S. S.	*b* 7	Do.

the protected cruisers "Columbia," "Minneapolis," and "Olympia," and the monitor "Puritan." There are 18 boats listed as "second rate," including protected cruisers and monitors. There are 22 "third rate" vessels, including cruisers, harbor defense ram, monitors, gunboats, and dispatch boats. There are 6 vessels under "fourth rate," including the dynamite cruiser "Vesuvius" and gunboats and cruisers. We have now 36 torpedo boats built and building and authorized, but in some cases the contract for them has not yet been awarded. We have 12 tugs, 6 sailing ships, 5 receiving ships, and 12 vessels which are unserviceable. There are 33 vessels under construction exclusive of the torpedo boats, but including the torpedo boat destroyers. We have 38 auxiliary cruisers and yachts, which include the formidable "Harvard," "Yale," "St. Louis," and "St. Paul." We have 33 steamers and colliers, used for supplying coal and provisions and for transport steamers, ambulance ship, supply ships, repair ship, etc. We have 27 tugs and 15 revenue cutters, as well as 4 lighthouse tenders and 2 Fish Commission vessels, but the latter two classes will not prove of much avail in the present war, although the lighthouse tender "Mangrove" has distinguished herself. It is noticed that the three first-class battleships, the monitors, and the destroyers for which contracts have not been awarded are to be given the names indicated in the table.

The following are the names of the new torpedo boats for which contracts have not yet been awarded: "Bagley," "Barney," "Biddle," "Blakely," "DeLong," "Nicholson," "O'Brien," "Shubrick," "Stockton," "Thornton," "Tingey," and "Wilkes."

The list of officers shows that we now have 7 rear-admirals on the active list; 10 commodores, 45 captains, 85 commanders, 74 lieutenant-commanders, 325 lieutenants of all grades, 170 ensigns, 70 chief engineers, 66 passed assistant engineers, 52 assistant engineers, 18 naval constructors, 19 assistant naval constructors, as well as 15 civil engineers. The information which the pamphlet conveys regarding the officers is, of course, very slight, but we notice under "Present Duty or Station" Richmond P. Hobson, "prisoner from 'Merrimac.'" The "Expiration of last cruise or tour of sea service" being "May, 1898." Under "Civil Engineers," "Leave of Absence" is placed opposite the name of Robert E. Peary.

DEVELOPMENT OF THE CARBIDE OF CALCIUM INDUSTRY.

BEFORE going into the commercial side of the industry, for we may dignify it by that name, it might be well to recall to our readers a few of the principal facts of scientific interest in connection with this new source of light, heat, and power and some new data which have just been made public.

Historical.—Calcium carbide was first made by Woehler in 1862, and although he did not completely analyze it nor determine its formula, yet the later experiments of Berthelot accurately determined sodium carbide, Na_2C_2, after which the formula for calcium carbide, CaC_2, could easily be written. This carbide was not produced in an electrical furnace, however, but was due to the reaction of carbon upon an alloy of zinc and calcium under the high heat of a Pernot steel melting furnace. Its next appearance was at the Cowles aluminum works at Lockport, N. Y., during 1886 and 1887. Their electric furnace, in which the aluminum was reduced, was lined by lime mixed with ground charcoal, the latter making the lime lining more rigid and less liable to soften, and the high temperature caused the formation of a crust of calcium carbide which was never analyzed, although it was observed to give off gas upon contact with water or moist air. In fact, as a practical joke, pieces of carbide were put into the pockets of visitors to the works, making them considerably at a loss to account for the peculiar odor they carried with them. However, it was not until May, 1892, that carbide was made as a product, and then it was an accident, for Willson was at that time trying, at his works at Spray, N. C., to reduce calcium from lime by heating in an electric furnace with carbon (carbonized tar), and he obtained instead a dark substance. Wishing to see whether it contained any metallic calcium, he threw it into water, and observed a gas coming off which he ignited; if the color of the flame had been blue and little luminous, he probably would have had calcium, but instead it was yellowish and smoky, and he did not know what he had, except that it must contain calcium and carbon, the substances he put into the furnace. No doubt he was not long in ignorance, as he sent samples of the material to Philadelphia and New York during that summer. Moissan had been working with a small laboratory electric furnace and found that small dark crystals formed where his carbons came in contact with lime. He carefully collected these, analyzed them, and reported to the French Academy of Sciences, with French precipitation, on December 12, 1892, that he had discovered a carbide of calcium—that is all—and it was not until March, 1894, that he described in detail its preparation and properties. When we consider that in an American patent application, No. 492,377, applied for on August 9, 1892, Willson announced the production of a carbide of calcium, the question of priority of discovery is disposed of at once. These two claimants both deserve credit for their work, having done it independently, but when it comes to a question of priority in patent litigation, the French claims will not stand. In fact, Bullier's carbide process patent has been canceled by the German patent office and his French master patent is also in danger. In America, Willson was unable to do anything with his carbide until it was taken up by Dickerson, who was one of those instrumental in preventing patent litigation by forming what is now the Electro Gas Company and in buying up all the foundation patents relating to carbide and acetylene, their manufacture and use. A lack of business methods swamped the other early acetylene companies, but at the present time both the parent companies controlling the business and the local small generator or lamp companies seem to have united in an earnest endeavor to do business in a businesslike way. Nevertheless, all is not gold that glitters, and there are some generators on the market got up by irresponsible mechanics which had better be left alone.

Properties of Carbide.—As is well known, when lime, CaO, is mixed with carbon and subjected to the temperature of about 3,000° C. (5,432° F.), the oxygen of the lime combines with the carbon to form a gas ultimately and the calcium remains as a metal. This metal, however, has the property of combining with carbon to form a carbide; in this case calcium carbide, CaC_2. This substance when perfectly pure is very dark in color, sometimes having a bluish iridescence, and with large, crystalline faces, probably of the hexagonal system. When the carbide is less pure and has cooled very quickly, it is close grained and is not so dark in color, especially when it contains unreduced lime. In general the color of carbide is a good index of its content in pure carbide, although it says nothing as to sulphides, phosphides, or silicides. Its specific gravity is 2·22, according to several authorities, which would make a cubic foot weigh 138·75 pounds. However, this would be solid carbide, and if we consider that but 60 per cent. of the cubic foot is actually occupied by the broken carbide, we will have a cubic foot of carbide, broken for generator use, to weigh about 80 pounds.

As to the impurities present in carbide, they may be disregarded at the present day, for improved processes and selected raw material have reduced them so low that there is absolutely no risk from spontaneous ignition due to high percentages of phosphorus, sulphur, or silicon compounds in the gas. Liability to ignition from this cause increases with the temperature at which the gas is generated, so that very high percentages of phosphide in the carbide of calcium may cause ignition in generators where the carbide is dropped into the water and then elevated while the gas is evolved; but this can take place only when oxygen is present in sufficient proportion—a condition not liable to exist in a generator. In 12 samples of carbide from Europe and America, Prof. Lewes found a maximum, in the acetylene generated from them, of 0·91 per cent., a trace as a minimum, and an average of 0·65 per cent. of phosphureted hydrogen. Calcium phosphide is less readily decomposed by water than calcium carbide; when water was dropped upon carbide, but one per cent. of phosphide was sufficient to cause inflammation upon the bubbles of gas coming in contact with the air, while, when the carbide was dropped into water, over 25 per cent. was necessary to cause inflammation. There is not over one one-hundredth of one per cent. of silicureted hydrogen in acetylene gas, and there is no danger from it in this direction.

Carbide is not affected by temperature out of contact with oxygen, but will burn quietly in the presence of oxygen, leaving lime as a residue. It is not actively acted on by cold concentrated acids, except hydrochloric, but the action is more pronounced with hot acids and very active with dilute acids. Any one who has examined a can of carbide, especially if not of the best manufacture, will have noticed the metallic particles which are not acted on by water. These may be iron, manganese, or silicon or combinations of them as alloys; in lesser quantity are found calcium, aluminum, and sometimes silicide of carbon (carborundum); there is almost always some unreduced lime and carbon. The center of the ingot of carbide is almost pure carbide, containing from 96 to 99 per cent. of pure carbide, but it is surrounded by a crust of considerable thickness where the temperature was not so high and which Prof. Lewes says contains from 50 to 70 per cent. of pure carbide. For ordinary use the two parts are crushed and mixed for generator use, which gives a carbide sufficiently rich. If the best pure carbide gives off 5·8 cubic feet of acetylene per pound, a 60 per cent. crust will give but 3·5, and a mixture may yield probably 5 cubic feet per pound. However, not all carbide is so pure, and it is not uncommon to get a bad lot with a shipment which will not yield over 3 cubic feet of acetylene per pound or even less. Since the improvements in process and machinery at Niagara Falls and Sault Ste. Marie, it is probable that this will not again occur. For use with portable lamps, cartridges, and small generators a rich carbide is now selected which will yield nearly the theoretical quantity of acetylene.

The same experimenter has just stated in a lecture that he found that one gramme of pure carbide liberated upon decomposition by dropping water upon it 444·6 calories, which would be equal to 201,361 calories per pound of pure carbide. As commercial carbide is seldom pure, it will not give out as much heat as this, but will be in proportion to the pure carbide present in the sample. Continuing this work, he determined the temperature of generation, attaining a maximum temperature of 700° C. to 800° C. in from 12 to 20 minutes, when using a "dip" generator. As acetylene decomposes into carbon and hydrogen at 780° C., this temperature might be dangerous when air is present in the generator or gas holder before generating; otherwise there would be no explosion, decomposition going on quietly. Under no conditions should any considerable quantity of air be permitted to enter an acetylene generator or gas holder, if absolute safety is desired. Air has no business there, and, if present, is an indication of criminal negligence somewhere. However, this high temperature is not liable to occur in any of the best forms of generators on the market; the forms where carbide is dropped into water never getting above the boiling point of water, and the others probably not getting much above the point where tar is formed during normal working. Of course, it must be remembered that if this quantity of heat is generated in too short a time and no provision is made to keep the vessel cool, a high temperature may result in even a good apparatus, so that they should not be taxed above their rated capacity. If the lime residue looks very yellow, it has been formed at too high a temperature—a point at which acetylene partly decomposes into benzine, tar, and other hydrocarbons, the tar coloring the lime and depositing in the pipes and burners. This latter inconvenience is a serious one and will have to receive especial attention in the near future. Deposits of liquid hydrocarbons at the burner are probably due to a small extent to burner temperature, but to a much greater degree it is the vapors which the gas brings from the generator. Atmospheric burners should not to any great extent deposit tar on their own account, and if they do, the generator will probably be found to be working too hot. When tar deposits in the pipes, as sometimes happens, and it catches lime dust carried along by the gas, there is an asphalt pavement made in the pipe which it is very difficult to remove without taking the whole pipe system apart. There are only a few generators on the market here to which this objection will apply, and they are cheap ones which will probably soon be worn out and thrown on the scrap pile.

It is not necessary for carbide to come into contact with water directly; atmospheric moisture or steam is sufficient to cause the generation of gas. In fact, there are some wick generators in portable lamps which depend upon this principle entirely and others which depend upon the absorption and capillary action of the lime to bring moisture to the unused carbide. Dr. Caro says that calcium oxide is first formed, then by the addition of more moisture this is hydrated into slaked lime. At a temperature of about 800° F. slaked lime loses its water, and as the temperature may rise to 1,300° F. or over, it is evident that, even if water is shut off, the carbide will continue to generate gas until it has used up all the moisture in the lime, and may even have a high enough temperature to extract the water of hydration from the slaked lime. This accounts for after generation, which may go on an hour after water is turned off. It occurs only where the water is dropped upon carbide and is impossible in the reverse system when the carbide chambers are perfectly tight.

We will not go any further into the generation of acetylene, but return to the manufacture of this substance.

Manufacture of Carbide.—As before stated, this is done in an electric furnace. Other systems have been proposed within the past year, and metallurgists are working upon combustion methods of producing the high temperatures of 3,000° C. to 3,500° C. which are necessary for the reduction of lime. It must be remembered by Bergmann, Borchers, and the rest that, although such a temperature were possible, which it is not, as the gases produced by combustion would be dissociated again at probably 2,700° C., a point much below that required, and that the highest temperature practically attained by such methods is about 1,800° C., or a little over half that which is necessary, there is no refractory material which a furnace could be made from which would stand the heat. In the most successful carbide furnaces the one carbon terminal is suspended in the bath, the other being a plate upon which the charge rests, inclosed in refractory walls. Here the crude material forms the walls of the furnace in reality, and the more it melts, the more product there will be. The charge makes an excellent non-conductor of heat, so that nearly all the current energy is expended upon chemical action, and there is likewise the advantage of little or no repairs to furnace walls. The suspended carbon pole, being kept constantly about the height of the liquid carbide, soon forms a short column of fused carbide, which is taken out and cooled, the unreduced charge being used over.

The charge is composed of some dense form of carbon. Carbonized sawdust or charcoal did not work well, but coke was better. Carbonized sugar is used for laboratory work, and carbonized oil is employed to great advantage. The carbon must be pulverized and mixed with lime freshly burned from pure limestone. Both coke and lime must be well selected, the former to keep down the sulphur and iron derived from pyrites in the coal and phosphorus in the ash, while the latter may contain phosphate of lime or magnesium carbonate, the latter being impossible to reduce in an electric furnace, and thus wasting current and interfering with the yield of the resulting carbide. Nothing should enter the charge that will give off gas, in order to keep the fusion as quiet as possible. After coming from the furnace the carbide used to be left in the yard to cool completely, after which it was freed from extraneous charge and slag and the crust removed if necessary. The operations about the works were very hard upon the workmen, by reason of the high temperatures and the floating particles of lime, the latter causing their noses to bleed frequently and other inconveniences. At present the ingots are cleaner and they are crushed, sized and packed before entirely cool, both to avoid waste and to secure a better product for the consumer.

For generator use the carbide is packed in sealed cans holding 100 pounds. These large cans are of tin, with well designed tops, and are protected against denting by a wooden casing. For works using large quantities, wrought iron strongly bound drums are used which hold several hundred pounds. Moisture proof coatings for carbide have got no further than the Patent Office. Some care must be exercised in taking carbide from a can just opened, especially if partly empty, as there will be some gas inside, resulting from the action of the moisture of the air inclosed with it, and this gas may be sufficient to burn the operator or may throw things about a little, if a flame is brought near it; either fan it free from gas or open only in daylight.

Lefevre says that theoretically one horse power per day will produce 5·34 short tons of carbide in twenty-four hours, or practically 4·27 tons. These were early figures and are wide of the mark. Lewes says: "When 18 tons of a mixture of 100 parts of pure lime and 68 parts of powdered oven coke of low ash are fused together in the electric furnace, one ton of calcic carbide is produced, while each electrical horse power per hour used in the furnace yields from 0·3 to 0·5 pound of calcic carbide. A considerable amount of carbide is lost during crushing and packing, and in practical working it is found that one electrical horse power per annum will yield from 1·25 to 1·5 tons of packed carbide."

There is no trouble in shipping carbide in this country, although it is under strict regulations on the Continent. Pending the experience brought by practice, European officials seem inclined to condemn carbide, and although they do not rank it as an explosive, they might as well, when one considers the safeguards they deem necessary. Carbide in itself is perfectly harmless when in airtight cans, but the moment it comes in contact with moist air or water it gives off gas, and it is this gas, when ignited, which may do injury. In some recent fires the buildings contained cans of carbide one or two of which were either open or pierced by falling material. The firemen directed a stream of water, which in this case was not a universal panacea, upon the cans of carbide, ostensibly to prevent their burning up, and thus generated large volumes of gas which caused great masses of yellow, smoky flame to rise amid flakes of soot until the carbide was exhausted, and then the firemen pronounced carbide as being dangerous. They said the same thing about oil when they first threw water upon it and found that the burning oil would float away upon the water, setting fire to every-

thing in its path. At temperatures to be found in places where carbide is stored during a fire it is not very probable that carbide would burn; at any rate, firemen should remember to keep water off it.

Carbide Works.—Although there are carbide plants at Lockport, N. Y., and Holcombs Rock, Va., they are not operating, the supply for the United States coming from Niagara Falls and Sault Ste. Marie, Mich. These works have shown remarkable development, both in quantity and quality of output. No one can realize the difficulties there were to contend with in bringing this simple process up to its present perfection. Outside of manufacture were such questions as irregular demand and consequent storage, of being managed by an office untrained in the business and who did not realize the needs of the works, of the general spirit of "booming" acetylene, regardless of fact and the mischief done by unscrupulous promoters in securing investments upon misrepresentations, the result being an unsatisfactory business and the dissolution of the operating company. While these unsatisfactory business methods were being practiced, the works under able chemists and electricians were gaining experience which finds its consequence in the improvements now going on and those just completed, and which have so increased the uniformity and quality of the carbide that 3 foot carbide is no longer to be had. The present situation, which will be of interest to all users or contemplating users of carbide, is as follows:

The Electro Gas Company own all the fundamental patents relating to electrical furnaces for reduction purposes, all carbide process patents and the principal patents relating to the use of acetylene, among which is one broad claim upon the use of acetylene for lighting. The Union Carbide Company has purchased the rights from the preceding to make calcium carbide and to sell it. They own the works at Niagara Falls and the "Soo," and operate them on their own account. Their purpose is to sell to generator users and large consumers principally, for which purpose they have divided the field into two districts, the Eastern and Western. The former has offices at 45 Broadway, New York City, and takes care of both the domestic and export trade, while the latter is in charge of W. P. Martin, 6 East Madison Street, Chicago. Carbide can be ordered from either of these places or contracts made, with the full assurance of a constant and uniform supply, as the works are now equal to the demand.

For use in portable lamps, such as bicycle or table lamps, the Electro Lamp Company has purchased the exclusive rights for the sale of carbide, but although they are makers of these lamps themselves, they will sell carbide to the users of lamps of any other make—a policy which is both generous and wise, and which will give a new stimulus to the industry. This carbide is selected stock, is dark in color, can be ordered in several sizes ranging from ¼ inch to dust, is packed in tin cases holding 2 and 5 pounds, the former retailing at about 25 cents, or in 100 pound cases at a lower price. This latter company, offices 45 Broadway, New York City, have a contract with the Union Carbide Company, at Niagara Falls, whose works are adjacent to theirs, for a continuous supply of carbide, so that orders can be promptly filled at all times. These carbide works have been so frequently described in electrical papers and proceedings that we will not touch upon it here. The Michigan works are especially active and have in operation a furnace which is of considerable interest. They are contemplating extensive additions to their works, have just given an order for twenty 500 horse power Walker generators to supply the carbide works on the American side of the "Soo," and made a contract with the water power company, who own a canal having a fall of 20 feet, for a period of 25 years, for the supply of 30,000 horse power and additional. The Union Carbide Company have a capital of $4,000,000, and are going into the business with an earnestness and method which is as refreshing as it is surprising in the carbide industry, and will no doubt bring their immense capital to bear with such telling effect that the rumors of orders for exporting carbide will be turned into fact, although there will be probably a dozen new carbide works put in operation in Europe during the next year. The product of the works in the United States during 1897 was 3,850,000 pounds, or 1,975 short tons.

In Canada the product of the Willson Carbide Works Company, at St. Catherines, Ontario, the only one in Canada, was, according to the official report of Bureau of Mines, 574 short tons during the 13 months ending December, 1897. From this and other official sources we find that during the 12 months of 1897, 80 tons of this was exported to the United States, 284 tons were exported elsewhere, and 196 tons were sold for consumption in Canada, making a total for the year of 560 tons. This carbide sells for $60 per ton. The sales are constantly increasing, being for Canada 9,361 pounds in January and 118,125 pounds in December. The exports to this country were none the first quarter and $2,120 the last quarter. This year's figures are not yet published, but no doubt we will import less since the new management has taken hold of our works. "To produce the 574 tons of calcium carbide, 768 tons of coke and 903 tons of lime were used, the value of the former being $2,646.37 and of the latter $2,707.39. The average number of workmen employed at the works was 30 and the amount of money paid out for wages during the year was $12,544.62." So says Director Archibald Blue. By this time the third lock on the Welland Canal, at Merritton, will be put in operation, placing 1,200 horse power at the disposal of the works, instead of the 800 horse power furnished by two locks during 1897. Willson has four furnaces in operation, 24 hours per day and every day (notwithstanding the scandal created by Sunday working), producing 3 tons of carbide daily. In 1896 the price was $80 per ton of 2,000 pounds, having dropped $30 up to the present time.

If the United States produced 3,850,000 pounds of carbide during 1897 and there was imported from Canada 160,000 pounds, there was a total of 4,010,000 pounds of carbide used. If we take the average yield of this carbide to be 4·8 cubic feet per pound, the acetylene gas used during that year aggregated 19,248,000 cubic feet. As 1 cubic foot of acetylene is equal in light-giving power to 10 cubic feet of city gas, the total would be equal to 192,480,000 cubic feet of illuminating gas. This would supply a town having a population of about 80,000 people with 25 candle flames. The prospects for 1898 are even brighter, so that acetylene for isolated lighting may now be looked upon as a commercial possibility.

ANALYSIS OF THE HORSE'S MOTIONS THROUGH CHRONOPHOTOGRAPHY.

The method that I have styled chronophotography, and which consists in taking upon a film that unrolls in the focus of an objective a series of instantaneous photographs of an animal in motion, is well known to the public in the form of animate projections. The photographic images that are projected successively at very short intervals become blended upon our retina into a continuous sensation which strikingly reproduces the appearance of the motion itself. But such images scarcely answer for the physiologist, who perceives therein nothing more than what an observation of nature would show him, that is to say, actions so rapid and complex that he is unable to seize the phases thereof. And yet the series of images contains all the elements necessary for obtaining a perfect knowledge of the motion of animals; but, to this effect, it is necessary to unite the images in a general figure with their relative positions in space, since a comparison between separate images is too difficult. Our mind does not preserve a remembrance of the first impressions faithfully enough when a series of others reaches us.

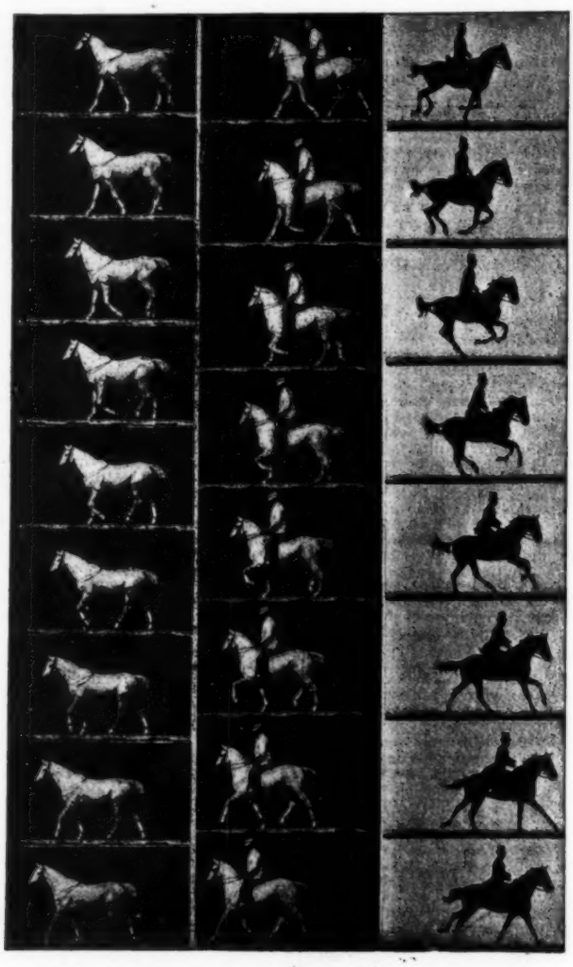
I once had recourse to a special method of chronophotography for the analysis of motions, and brought together upon the same plate a series of well-lighted images of an animal passing in front of a dark ground. This method was perfect in certain cases, such as when one operated upon an object or an animal of small dimensions moving with speed. The successive images then arranged themselves in their respective places without becoming confused with each other, and it was possible to obtain a true geometrical diagram of the motion under study. But animals of large size, especially in their slow gait, gave images that lapped over one another, those of their hind limbs becoming confounded in an intricacy impossible to decipher. Fortunately, by means of certain artifices, it is possible to assemble the separate images of the chronophotograph upon a movable film, and from this to draw a diagram of the motion. It is possible, even, to combine the form of the bones and muscles with the diagram of the external forms, and thus obtain a knowledge of the hidden mechanisms of which the motions of the animal are merely an external manifestation.

It is this method that I am going briefly to describe. For a starting point of the operations, we take a series of chronophotographic images of a horse such as are shown in the last of the accompanying engravings. The dimensions of the page have permitted of representing only half of a step, save with the gallop, in which the succession of the motions is more rapid.

The film that carries the images of a horse on a trot is introduced into a projection lantern. The luminous pencil, reflected upon a mirror inclined at an angle of 45 degrees, forms a large-sized image of the horse upon a horizontal sheet of drawing paper. The contours of the image are followed with a pen in limiting it at the head and right foreleg in order to avoid any confusion (Table I., Fig. 1). We likewise draw the line of the ground, the extremities of which will serve as datum points for subsequent projections. The image that we transfer in the first place is the last of those that correspond to the series of a step. We then project the second image and arrange the drawing board in such a way that this image shall be well in its place. This may be judged of by the perfect concordance of the ground line and its two extremities with the same points of the preceding transfer. In making this second transfer, we dot the contours that are regarded as covered by the image already drawn. The third image is drawn in the same way, and then the series of other images, until we have figured a number of attitudes equal at least to that which corresponds to the duration of one step of a trot.

These images thus assembled (Fig. 1) recall the results that chronophotography gave upon a fixed plate; but they present no confusion.

Table II., obtained in the same manner, represents the successive attitudes of the right hind leg. In these simple outlines, we already find numerous data as to the manner in which the fore and hind legs act, and as to the very similar trajectory of the two feet during their ascent, and as to the direction of the legs at the moment at which they strike the ground and rise from it. It will be seen that, at the moment of the lifting, the animal lowers the neck and shoulders. This is the effect of the action of the levator scapulæ, the upper insertion of which is found at the vertebræ of the neck.



THE DIFFERENT GAITS OF A HORSE STUDIED THROUGH CHRONOPHOTOGRAPHY.

I shall not dwell upon these details, which have already been made known in a study upon the exterior of the horse by means of chronophotography.

It is a question now of determining in these images of the legs the position assumed at every instant by the various parts of the skeleton, and the state of contraction or elongation of the different muscular groups at the successive instants of the step. In the first place, as regards the skeleton, it is necessary to slaughter the animal, prepare the bones of its legs and photograph them on the same scale as the living animal. This constitutes the great difficulty of an experiment of this nature, if we operate upon a costly animal.

A favorable circumstance has supervened to overcome this difficulty. The state stallions, after they have been retired from service, have to be slaughtered. Prof. Le Hello, of Haras-du-Pin, has thus been able to have the trotter Tigris sent to the physiological station in order to be slaughtered there after being submitted to chronophotography.

Immediately after being killed, Tigris was dissected and his muscles weighed for future study. A skeleton of his legs was then prepared along with the articula-

tions, in order that a photograph of them might be taken. These images of the skeleton, projected upon the same scale as the outlines of the animal, were cut out in such a manner as to give the various profiles of the bones under the form of small patterns that were fitted into the profile of the legs, and the contours of which were drawn as seen in Figs. 2 in the two tables.

It would have been impossible, and experiment has demonstrated it to me, to place in the profiles of Tigris the skeleton of any other horse whatever. Between one animal and another, there are differences of proportions too great between the osseous radii. In the present case, the two transfers fit of themselves with accuracy. It may be seen, in fact, that the osseous projections of which the relief is outlined under the skin fall well into their places. Here, then, we have the successive attitudes of the skeleton determined for the successive instants of the trot. This double figure, necessary for the construction of the diagram, may seem to be somewhat complicated if we wish to analyze the motions of the skeleton. This latter is isolated muscle at the moment considered. As the muscles are not contractile in their entire extent, but only through their red fibers, there has been taken from the straight line that represents each muscle a constant length at each of its extremities. This part corresponds to the tendons, while the middle part, marked with a darker line, corresponds to the contractile fiber. This diagrammatic representation has the advantage of rendering the elongations and contractions more sensible by placing such variations on a shorter line.

However, although the original figure was of somewhat large dimensions, it was difficult to grasp therein the phases of elongation or contraction of the various muscular groups. These phases have been rendered more sensible by means of curves which, in our two tables, surmount Fig. 4. They were obtained by placing as negative ordinates, under each image of the horse, a length corresponding to that of the muscle considered. In Fig. 4, the same letter designates the muscle and the curve of its changes in length. Thus, in Table I., which corresponds to the fore leg, the letter *A* designates the teres major with its scapulo-humeral insertions. This same letter is found again opposite the curve of variations in the length of the teres major. The same is the case with the supraspinatus, triceps, and biceps. Finally, in Table II., the muscles of the hind leg and their curves are likewise designated by the same letters in common.

An inspection of these curves shows that for each leg there exist muscles having alternating actions and one of which contracts while the other is relaxing. This is due to the alternate convergences and divergences of the curves, *A* and *B*, in the two tables. These antagonistic muscles are, in the fore leg, the teres major and supraspinatus and, in the hind leg, the ischio-tibials and rotulians.

However, the muscular actions are not homologous in the two legs, as the scapulo-humeral muscles act only upon the articulation of the shoulder, while in the hind leg, the antagonists, running from the pelvis to the leg, control the motions both of the haunch and the knee.

Despite such difference, we are struck by the analogy of the motions of the cubitus with those of the calcaneum. This shows, as has been observed by M. Baron, that functional adaptation has caused bones which are not anatomically homologous to acquire a similar action.

The curve, *C*, of Table II. represents the action of the gastrocnemii. It offers a singular peculiarity, for we here see small undulations in the direction of the contraction, although the extension of the muscle is limited, the curve of the maximum lengths being reduced to a straight line. Now anatomy gives an account of this exceptional phenomenon. The gastrocnemii contain in the interior of their contractile fasciculi a sort of inextensible tendinous cord. This latter does not prevent the muscles from shortening during their contraction, while in the phase of relaxing it opposes an insurmountable obstacle to their elongation. This arrangement assures the interdependence of the articulations of the knee and foot, the extension of the first necessarily involving that of the second.

In order to show better to what moment of the action of the legs correspond the contractions of the different muscles, a notation of the planting and lifting of the foot has been drawn beneath the curves. A very heavy black horizontal line marks the duration of the bearing of the foot and a double white line the lifting of the same.

It is unnecessary to point out the many data that may be obtained from an inspection of these figures. One may pass from one to the other according to the details that he may desire to obtain therefrom. What has just been read suffices to show that from chronophotography may be naturally derived, through operations that are quite simple, a host of data upon the complicated mechanism of the gaits of the horse. It is

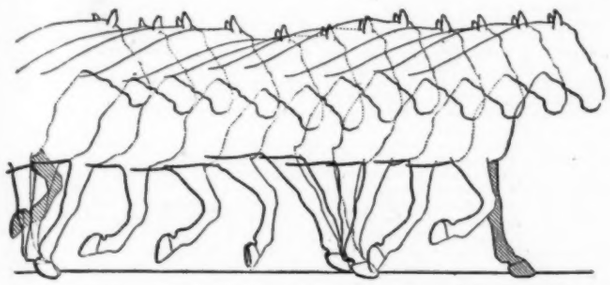


FIG. 1.—SUCCESSIVE ATTITUDES OF THE RIGHT FORE LEG ON A TROT.

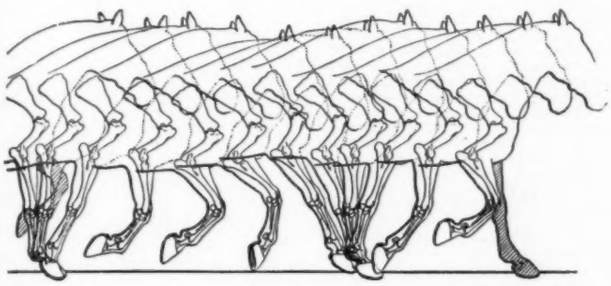


FIG. 2.—POSITIONS OF THE SKELETON IN THE INTERIOR OF THE LEG IN EACH OF ITS ATTITUDES.

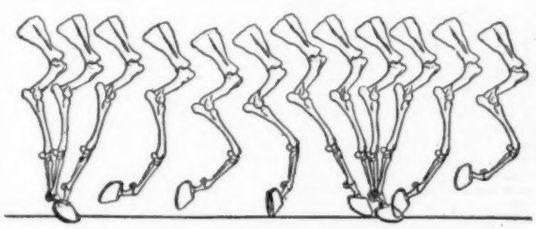


FIG. 3.—ATTITUDES OF THE SKELETON ALONE.

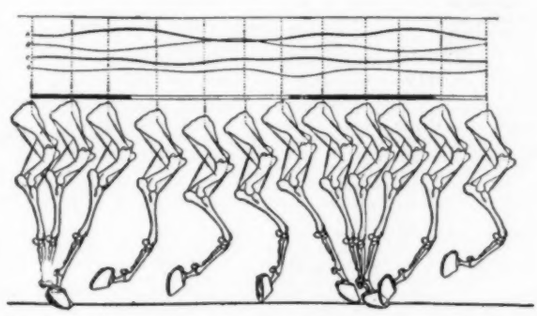


FIG. 4.—SKELETON—THE LIFTING AND PLANTING OF THE FOOT.

Curve of the various muscles: A, the teres major; B, the supraspinatus; C, the triceps; D, the biceps.

TABLE I.—TIGRIS ON A TROT (RIGHT FORE LEG).

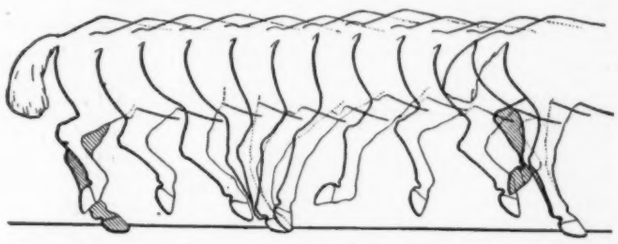


FIG. 1.—SUCCESSIVE ATTITUDES OF THE RIGHT HIND LEG ON A TROT.

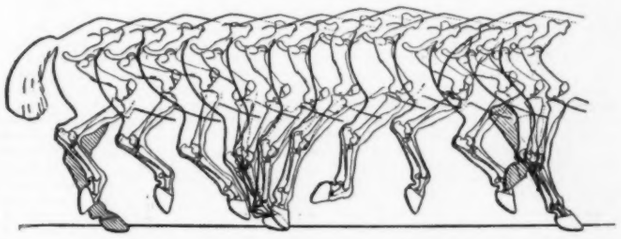


FIG. 2.—POSITIONS OF THE SKELETON IN THE INTERIOR OF THE LEG IN EACH OF ITS ATTITUDES.

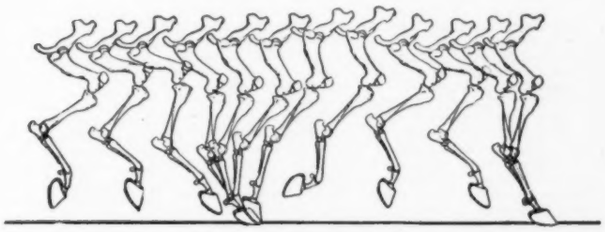


FIG. 3.—ATTITUDES OF THE SKELETON ALONE.

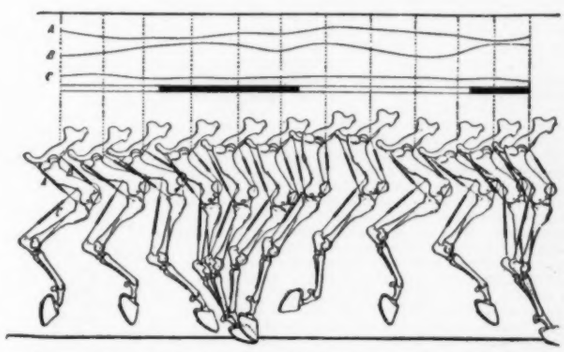


FIG. 4.—SKELETON—LIFTING AND PLANTING OF THE FOOT.

Curves of the different muscles: A, the ischio-tibials; B, the rotulians; C, the gastrocnemii.

TABLE II.—TIGRIS ON A TROT (RIGHT HIND LEG).

in Figs. 3, which better translate the play of the articulations as well as the displacements of the shoulder and pelvis. It will be clearly seen, for example, that the shoulder descends under the weight of the body at the beginning of the lifting of the foot. At the end of the lifting, on the contrary, the shoulder is raised, as above stated, by the muscles which, on another hand, lower the neck and shoulders. But, aside from the various data given by a study of the skeleton, the latter permits also of knowing, at every instant, the state of contraction or elongation of the different groups of muscles.

Anatomists have determined the place of insertion of each muscle of the horse upon the bones. If, then, according to M. Barrier's tables, we mark in Figs. 3 the mean position of the attachments of a muscle, and if we join these two extreme insertions by a straight line, the length of the latter will represent that of the

from figures of this kind that Prof. Le Hello has established his new theory of the mechanism of progression.*

I have applied the same method to the study of the mechanism of locomotion in a large number of animal species and at different gaits. My object has been to study the anatomy and physiology of the locomotive apparatus comparatively.—E. J. Marey, in La Nature.

HOW TO SELECT A TELEPHONE.

By H. P. CLAUSEN.

FOR the inexperienced telephone exchange manager it is a very difficult problem to select a telephone instrument best suited for his requirements. From the very beginning he has absolutely no confidence in the often conflicting statements made by rival manufacturers of telephone apparatus; therefore, he relies much more on an opinion given by the user of a certain type than he does on the claims of the maker of that particular instrument. On first thought it may appear to be the best plan to first consult the user of an instrument under consideration and then consult the manufacturer; however, this is not always true, unless, perchance, the instrument required shall meet the same conditions exactly as those that are met by the instrument of which a practical trial has been made. Therefore, if it become necessary to meet conditions not found in the system tested, an instrument constructed on a radically different plan may be required; in fact, the instrument required for one class of service might be almost useless if employed in connection with an instrument built to meet other conditions, though both may have been constructed by the same maker, and in outward appearance differ in no respect whatever.

Suppose, however, that you have confidence in what a certain manufacturer might suggest, and that you ask him to quote a price on the telephone instrument it would be best to employ in connection with your system. The chances are that he will send you, with the price list, a few simple questions, which you are supposed to answer. If you neglect to furnish the desired information, but send an order, you may be sure that the order will be entered for instruments such as are employed for ordinary service, and perhaps not at all suitable for your requirements. Therefore, make it a rule to give the maker of an instrument all the information he wants relating to the manner and conditions under which you are going to operate the telephone. There is no better plan for getting just what you need, assuming, of course, that it is a responsible concern with which you are dealing.

Another suggestion for the "green" telephone manager is that it is far better when buying a telephone, the ins and outs of which he does not fully understand, to admit a little ignorance and let the salesman answer for possible mistakes, than to take the entire blame by exhibiting a superior knowledge of the apparatus under consideration.

When the necessity arises of purchasing a large number of telephones for exchange service the first cost generally receives the most consideration, whereas the maintenance expenditures that must develop sooner or later in a cheap grade of instruments seldom receive any attention at all. For use on the metallic circuit system the telephone employed need not be quite as expensively constructed as the instrument that is required to give an equally efficient service on a ground-return or common wire return (McCluer) system, for in the metallic circuit system the telephone is not liable to many serious interferences that are met with in the common return system. In contracting for a large number of telephones many points should be considered that may be relatively unimportant of themselves, but of considerable value in their relation to the conditions of operation and as bearing directly upon the question of first cost and operating expenses. The character and quality of the apparatus makes this unavoidable. Attention is therefore demanded for the essential features of construction. Let us examine the apparatus and consider the work it is intended to do.

The signaling apparatus of a telephone consists of the magneto-electric generator and a polarized magneto bell. The generator is employed at the telephone instrument for the purpose of enabling the user to conveniently generate an electric current sufficiently strong for the energizing of an electro magnet placed on the switchboard at the central office. The electro magnet is arranged with an armature and the call recording shutter, and when properly adjusted requires only a very small amount of current, that is, about 0·01 of an ampere, or, more clearly, the current that passes through an ordinary telephone receiver connected in series with one cell of battery should throw the annunciator drop. The average line resistance of a metallic circuit system usually is less than 300 ohms, and a magneto generator that will cause a call to be recorded over 10 times 300 ohms, that is, 3,000 ohms, would give an entirely satisfactory service. The generator, however, employed in connection with a ground return system should be capable of sending a signaling current through a line resistance of at least 6,000 or 7,000 ohms, for the liability of poor ground connections, partial grounds on the line wires, and other outside interference is great. Moreover, some manufacturers prefer to install a less sensitive annunciator drop at the central office, for the obvious purpose of preventing the recording of a call signal by every stray current that might pass over the line. The same rule, though somewhat modified, applies to the common wire system.

The signal receiving apparatus of a telephone consists of two polarized electro magnets, so set in relation to a movable armature that an attraction or repulsion of either pole will cause the armature to be moved to and fro. An extension of the armature is arranged for alternately striking one or the other of a pair of gongs, thus producing at the telephone the usual audible signal.

As a general rule, the first care of the wary purchaser of a telephone is to receive an assurance that the instrument he desires to purchase will ring through a certain resistance, usually 10,000 ohms, but sometimes this requirement is raised to 30,000 and even 50,000 ohms resistance. To meet such extreme and only too often useless requirements, the manufacturer is compelled to make a more sensitive magneto ringer than is actually necessary for giving an efficient service. Though it may be true that it is some satisfaction to be able to ring a bell through a very large resistance, it is equally true that a talking service is far from satisfactory, if obtained at all, between the extremities of telephone circuits over 7,000 or 8,000 ohms in resistance. Normally, the magneto ringer coils must be left in circuit with the line wires, and they are therefore always exposed to the damage that an accidental cross with highly charged wires might produce. For that reason the manager in selecting an instrument should make it a point to ascertain how much current the ringer coils will carry with safety, and not how small a fuse wire will protect the coils against burning out. The former, when known, will quickly help determine whether the fuse wire you must employ is of a sufficiently large size to warrant any certainty of action when the occasion arises.

The question has been asked by many: "What receiver is it best to employ, the single pole or the double pole?" Considering the first cost and the probable maintenance expense, there is little choice. The single pole receiver costs less in the first place, but calls for more attention, whereas the double pole receiver costs more but demands less attention when giving an everyday service.

There has been some discussion regarding the advisability of winding the receiver coils for a lower resistance for the purpose of eliminating somewhat the effects of extraneous disturbances, such as the inductive noises usually caused by high tension currents on wires running parallel or passing over the telephone wires of a common return exchange system. It may be said that there are in daily service double pole receivers wound for 6 ohms resistance, which give very satisfactory results, where the regular 75 or 100 ohm receiver was not at all satisfactory. The telephone receiver is a very delicate instrument and requires to be well made, but it should not be made more sensitive than is really necessary for the proper reproduction of speech, for it is the voice current that is to be conveyed to the listener's ear, and not the pernicious wail of every wayward line of force.

The telephone transmitter is a very important part of the telephone, and good judgment should prevail in its selection. Outside appearances go for naught. The fact that an instrument talks well on making a general test does not indicate that it will continue to talk well. The American Bell Telephone Company, with its numerous able engineers and immense corps of assistants, required over ten years of experimenting before the present standard, "the solid back," was developed and adopted, together with its inherent faults.

Most transmitters may talk well for quite a long while, but, after some time, there is a gradual falling off in the general efficiency—the batteries require recharging more often than seems necessary, the receivers, the line wires, the switching appliances, and the trouble men, are all called on to take a share of the difficulties an ailing transmitter may produce. The best plan to follow in the selection of a transmitter is to see that the containing case proper is made of solid metal. The diaphragm, if made of a metal, should be at least three inches in diameter, and if composed of a pressed carbon disk, it should not be less than two inches in diameter and well protected against accidental mechanical damage from the outside.

The office of an induction coil is to transform the variations of an electric current produced by a microphone, connected in series with the battery and the primary winding of the induction coil, into currents that have greater ability than the mere battery current would have of forcing their way through large resistances. The primary winding of an induction coil should consist of as few turns of wire as may be consistent with the transmitter and battery employed. The secondary winding, it must be remembered, is a part of the receiving circuit, and as it offers a certain amount of resistance to the so-called voice currents, its resistance, or more properly its apparent resistance, to the voice current should be comparatively low. Practically in a telephone circuit the best results are obtained when the apparent resistance of the telephone receiver and the secondary winding of the induction coil employed are equal. However, it may be safely assumed that the induction coil, when employed as a part of the telephone, will cause less trouble and require less attention than any other part of the instrument.

The telephone employing a local battery should be equipped with an automatically operated switch that either connects or disconnects the battery as needed. The switch must also produce at the proper time either of two conditions in the telephone circuit, that is, normally a signaling or call receiving circuit, and a talking circuit when the instrument is required for a conversational purpose. For practical reasons a switch that is operated by removing the telephone receiver from its support is the best for an ordinary service. The purchaser that has some knowledge of mechanics will have no difficulty in selecting a good switch out of a lot of fairly good switches; however, the primary requirements may be mentioned. The telephone switch must perform exactly the same functions as any other kind of electrical switch by connecting the battery to the transmitter circuit and the secondary circuit to the line wires. The mechanical construction of a telephone switch should be such that the friction of all movable parts is reduced to a minimum. The body of the switch should be constructed so as to allow rigid fastening to the containing case, and the lever or receiver supporting prong must be sufficiently strong for preventing any serious damage done by every careless operator. The electrical requirements are that the contacts must always be made firm. Perhaps the least possible sliding motion is an advantage when the contacts are at all exposed to the collection of dust particles, but as the sliding motion creates a wear at the point of contact, it is doubtless better to select a hook wherein the contacts are made direct and properly protected against the accumulation of dust. It is needless to say that all contact points should consist of platinum and be fastened to the springs proper either by clamps, wedges, or, what is the best plan, riveted fast directly to the springs.

Different people entertain widely differing opinions relating to the kind of wood that should be employed in building a telephone instrument. The old telephone manager, however, will not for a moment hesitate in recommending as the best a solid walnut cabinet, and with good reason, for the walnut woodwork will retain its true color always, whereas the originally bright color of the oak telephone is soon replaced by a fly specked and a generally unclean appearance.

The writer's lack of faith in the serviceability of the lightning arresters such as are usually placed directly on the telephone will not permit him to make any special recommendations. However, the presence of a grounded plate near the line binding posts, if mounted on a wood base, is a fire trap of the worst kind. Moreover, it does not offer the protection desired, for the lightning arresters should be mounted separately and on a non-combustible base in combination with a fuse wire of the proper size for protecting the telephone. In many cases it is preferable to employ a fuse wire only, which, if properly constructed, offers ample protection against atmospheric discharges.—Western Electrician.

FOLK-MEDICINE IN ANCIENT INDIA.

"THE most primitive witchcraft," says Sir Alfred Lyall, "looks very like medicine in the embryonic state." This is pre-eminently the case in ancient India, where it is not difficult to trace the history of medical science—such as we find it in scientific works on medicine, like the Charaka or Susruta—back to its early beginnings in the charms and witchcraft practices of the Atharva-veda, the most ancient compendium of sorcery.

In India, as elsewhere, the general doctrine of disease prevails that all abnormal and morbid states of body and mind are caused by demons, who are conceived either as attacking the body from without or as temporarily entering the body of man. The consequence is that primitive medicine consists chiefly in chasing away or exorcising these hostile spirits. This is done, in the first instance, by charms. The spirit of disease is addressed with coaxing words and implored to leave the body of the patient, or fierce imprecations are pronounced against him to frighten him away. But these charms, powerful as they are (in fact, there is nothing more powerful to the primitive mind than the human word, the solemn blessing or curse), are yet not the only resource of the ancient physicians or magicians.

From the earliest times people had become aware of the curative power of certain substances in nature, especially of herbs. This knowledge was first gained by experience, and, after it had once been obtained, people began to ascribe similar curative power to plants, as well as to animal and mineral substances for various other reasons. Analogy or association of ideas serves to explain not only many of the practices of primitive medicine, but also accounts in many cases for the belief in the curative power of certain substances. The principle that similia similibus curantur prevails throughout the whole range of folk-medicine. Thus dropsy is cured by water. A spear amulet is used to cure colic, which is supposed to be caused by the spear of the god Rudra. The color of a substance is of no small importance in determining its use as a medicine. Thus turmeric is used to cure jaundice. Red, the color of life-blood and health, is the natural color of many amulets used to secure long life and health. A black plant is recommended for the cure of white leprosy. But even the name of a substance was frequently a reason for ascribing to it healing power. One of the most powerful medicinal or magical plants is called in Sanskrit apāmārga (Achyronthes aspera), and it owes its supposed power essentially to its etymological connection with the verb "apamarj," meaning "to wipe away," and in Hindu charms the plant is constantly implored to wipe away disease, to wipe out demons and wizards, to wipe off sins and evils of all kinds.

To wipe a disease away is a very common and a very natural means of getting rid of it. This seems to be the meaning also of that ancient method of curing disease by the laying on of hands, which is already mentioned in the Rig-veda, though it is also possible that it was intended to press the disease down by means of the hands in order to make it go out of the body. Some of the charms used with the laying on of hands point to still another explanation. As the priest had to touch the person for whom he was offering prayers and sacrifices, so it was thought that the imprecations could only have effect on a person if there was an actual connection between the medicine man and the patient. There is a striking similarity between this ancient Hindu custom and the modern practices of faith healing, in which, after all, prayer has merely been substituted for the ancient charms.

The two chief resources of folk-medicine, then, are charms and magic rites, the principal object of the latter being to bring the body into contact with some supposed curative substance. These substances are frequently applied in the shape of amulets or talismans.

The most ancient collection of charms is that found in the Atharva-veda, an excellent translation of which, with extracts from the ritual books, has just been published by Prof. Bloomfield in the "Sacred Books of the East" (vol. xlii., 1897). In the medical charms of the Atharva-veda the diseases are always personified. It is only our way of speaking when we say that diseases are supposed to be caused by demons. As a matter of fact the diseases themselves are addressed as personal and demoniacal beings. Thus Fever—"the king of diseases," as it is called in the "Susruta," the great work on Hindu medicine—is addressed as a demon who makes men sallow and inflames them like a searing fire. He is implored to leave the body, threatened with destruction if he does not leave it, and yet at the same time worshiped as a superhuman being. "Having made obeisance to the Fever, I cast him down below." This is a very characteristic way of dealing with evil spirits, which we find among all primitive people. The healing power, too, is addressed as a supernatural being and invoked to destroy the demon of disease. Thus the plant Kushtha (Costus speciosus), which was always considered by the Hindus as one of the most potent remedies against fever, leprosy, and other diseases, is addressed with such words as: "O plant of unremitting potency, drive thou away the fever that is spotted, covered with spots, like reddish sediment." In some of the charms against fever we meet with vivid descriptions of all the symptoms of malarial fever. We read in one charm: "When thou, being cold, and then again deliriously hot, accompanied by cough, didst cause the sufferer to

* Comptes Rendus de l'Academie des Sciences, June 8, 1896.

shake, then, O Fever, thy missiles are terrible: from these surely exempt us!" And the Kushtha plant is again implored: "Destroy the Fever that returns on each third day, the one that intermits each third day, the one that continues without intermission, and the autumnal one; destroy the cold Fever, the hot, him that comes in summer, and him that arrives in the rainy season!"

The frequency of fever during the rainy season probably accounts for the belief that lightning is the cause of fever, as well as of headache and cough. A very symbolical cure of fever consists in making the patient drink gruel made of roasted grain, the dregs of the gruel being afterward poured from a copper vessel over the head of the patient into fire, which must be taken from a forest fire. A forest fire is supposed to have originated from lightning, and that the cure of a disease is effected by that which causes it is an almost universal belief. Both the roasted grain and the copper vessel are symbolical of the heat of fever. Here we have the rudiments of homeopathy. Another magic rite is intended as a remedy against cold fever. By means of a blue and a red thread a frog is tied to the couch on which the patient reclines, and a charm is recited in which the fever is invoked to enter into the frog. The frog represents the cold element, and the cold fever is expected to pass into the cold frog. A very similar charm is met with in Bohemia, where the peasants, in order to cure chills of fever, catch a green frog, sew it into a bag, and hang it around the neck of the patient.

The cure of a disease by making it enter into some animal is one of the most general devices of medical witchcraft both in India and elsewhere. According to Jewish law, a living bird is "let loose into the open field with the contagion of leprosy." Jaundice is cured, in parts of Germany, by making it pass into a lizard. In ancient India, jaundice was cured by seating the patient on a couch beneath which yellow birds were tied. The yellow disease was expected to settle on the yellow birds.

The principle of curing a disease by something similar to its cause or symptoms is also apparent in the cure of excessive discharges by means of water. Dropsy—the disease sent by Varuna, the god of the sea and of the waters—is naturally cured best by the use of water. A very simple cure of dropsy consists in sprinkling water over the patient's head by means of twenty-one (three times seven) tufts of sacred grass (Poa cynosuroides), together with reeds taken from the thatch of a house. The water sprinkled on the body is supposed to cure the water in the body.

But there must have been many other reasons, too, which pointed to water as a great healing power. To the present day the Hindus look upon rivers as divine beings or as the abode of spirits. And we may credit even the ancient Hindus with a certain knowledge of medicinal springs. Nor is it surprising that in a tropical climate the rain waters were hailed as "divine physicians." And it may be that actual experience of the beneficent influence of water on health suggested the eulogy found in a Vedic charm: "The waters verily are healing, the waters chase away disease, the waters cure all diseases."

That dropsy is ascribed to Varuna, one of the great gods of the Hindu pantheon, is quite exceptional. For, as a rule, diseases are caused by godlings rather than by gods. More especially, all such diseases as mania, fits, epilepsy, convulsions, etc., are ascribed to possession by Rakshas (devils) and Pisāchas (goblins). Even in the scientific works on medicine, e. g., in the "Charaka-samhitā," assaults of evil spirits and possession by demons are enumerated among the causes of disease. In the Atharva-veda we find a special class of charms, the so-called "driving-out charms," which are considered as most effective remedies against possession.

But the most powerful enemy and destroyer of all devils is the Fire. "Slayer of fiends" is one of the most common epithets of Agni, the god of fire. Hence we find that Fire is invoked in charms against mania to free from madness him who has "been robbed of sense by the devils." Sacrifices to the god of fire, burning of fragrant substances, and fumigation are among the principal rites against possession by demons.

Besides the Rakshas and Pisāchas (devils and goblins), whose special province it is to cause all kinds of mischief, we find in ancient India also the world-wide belief in incubi and succubi, who pay nocturnal visits to mortal men and women. These are the Apsaras and Gandharvas of Hindu mythology, who correspond to the elves and nightmares of Teutonic belief. They are really godlings of nature. Rivers and trees are their natural abodes, which they only leave in order to allure mortals and injure them by unnatural intercourse. To drive these spirits away, the fragrant plant ajasringi, "goat's horn" (Odina pinnata), is used, and certain charms are pronounced. According to Teutonic belief also fragrant herbs (e. g., Origanum antirrhinum, Hypericum perforatum, and especially thyme) are excellent means for frightening away devils and witches, as well as nymphs and elves.

That the spirits of trees and waters are occasionally identified with the spirits of disease may to some extent account for the healing power ascribed to water and trees. In fact, the far-spread custom of transferring diseases to trees seems to have originated from a desire of infecting the spirit of a tree with a disease which may have been caused by the same or an allied spirit. Amulets as a protection against diseases, hostile sorcery, evil eye, and other calamities are frequently taken from trees. Thus, an amulet consisting of splinters from ten kinds of holy trees was considered by the ancient Hindus as a potent remedy against hereditary disease, and also against possession by demons. Nine kinds of wood are used for a similar purpose in German folk-medicine.

As these malevolent spirits are the sworn enemies of mankind, it is only natural that they should be most anxious to injure the new-born infant, and even the embryo. Numerous, therefore, are the charms and rites concerned with the protection of mother and child against the attacks of evil spirits. Hence the custom of keeping a fire or a light burning in the lying-in room—a custom found among tribes of the Malay Peninsula, prescribed in the sacred books of the Parsis, and still practiced in Germany, as it was in ancient Rome. In ancient India, the rule was to keep a fire burning near the door of the lying-in room, in which mustard seeds and rice chaff were sacrificed every morning and evening for ten days. Visitors, too, were requested to throw mustard seeds and rice chaff into the fire before entering the room.

The chapter of children's diseases is as large in medical witchcraft as in modern medical science, and in the Hindu charms we find numerous names of demons to whom the various diseases of children are ascribed. One of these demons is called the "Dog-demon," and is said to represent epilepsy (though the barking dog would remind us rather of whooping-cough). When a boy was attacked by the dog-demon he was first covered with a net, and a gong was beaten, or a bell rung. Then the boy was brought into a gambling hall—not, however, by the door, but by an opening made in the roof; the hall was sprinkled with water, the dice cast, the boy laid on his back on the dice, and a mixture of curds and salt poured over him, while again a gong was beaten. To drive evil demons away by means of loud noises, such as the beating of a gong, was a device frequently resorted to in ancient Hindu rites, and bells and drums are still used in India as scarers of demons. Interesting is the practice of bringing the child into the hall through an opening in the roof—that is, not by the door. To enter a house by any other opening but the door seems to be a means of escaping the demons who are haunting the threshold. Thus, according to a German superstition, it is conducive to the health of a child to lift it out of the window when it is taken to church to be baptized.

Of course, the ancient Hindus knew that some maladies and derangements of the human body were not caused by any mysterious power; they knew that wounds were inflicted by weapons, they knew something about the effects of poison, and had an idea that certain diseases were caused by animals, such as worms. But in ancient India, as well as German folk-medicine, the term "worms" includes all kinds of reptiles, and snakes and worms are not kept very distinct. Moreover, all kinds of diseases were ascribed to worms. And both worms and snakes are actually considered as a kind of demoniacal beings. The imprecations against worms are, therefore, not much different from the charms against the demons. Thus we read in a charm against worms in children: "Slay the worms in this boy, O Indra, lord of treasures! Slain are all the evil powers by my fierce imprecation. Him that moves about in the eyes, that moves about in the nose, that gets to the middle of the teeth, that worm do we crush." This fierce imprecation is accompanied by a rite symbolical of the destruction of worms in the patient. An oblation of black lentils, mixed with roasted worms and with ghee, is offered in the fire. Then the sick child is placed on its mother's lap, and with the bottom of a pestle heated in the fire and greased with butter, the palate of the child is warmed by thrice pressing upon it. Then a mixture of the leaves of a horse-radish tree and butter is applied, and twenty-one (three times seven) dried roots of Andropogon muricatus are given to the child, upon whom water is poured.

The words of the charm leave no doubt that not only intestinal diseases, but also pains of the head, the eyes, etc., are ascribed to worms. Thus, German folk-medicine knows of a "finger-worm" as the causer of whitlow (Panaricium), and even spasm in the stomach is ascribed to a worm, the so-called "heart-worm" (Herzwurm). As the Hindu charm mentions a worm "that gets to the middle of the teeth," so worms are believed to be the cause of toothache almost in every part of the world. "If a worm eat the teeth," says one of the prescriptions in an English "Leech Book," take holly rind over a year old and root of carline-thistle, boil in hot water, hold in the mouth as hot as thou hottest may." In Madagascar the sufferer from toothache is said to be "poorly through the worm."* In a French charm against toothache it is said: "Si c'est une goutte de sang, elle tombera, si c'est un ver, il mourra." In Germany a sufferer from toothache will go to a pear tree, walk three times round it, and say: "Pear tree, I complain to thee, three worms sting me, the one is gray, the other is blue, the third is red—I wish they were all three dead." A young Hindu friend of mine (now a student at Oxford) tells me how he remembers the witch coming to his father's house (in Calcutta) to cure persons suffering from toothache, and how after some hocus-pocus she would point to some cotton threads she held in her hand, saying: "Look, here are the worms which I have taken out from your teeth."

In the Buddhist scriptures we read of an extremely clever physician, Jīvaka, who performed many marvelous cures. Once upon a time, we are told, there lived in the capital of Magadha a rich merchant who had been suffering for seven years from a disease in the head. Many renowned physicians came to see him, received much money, and went away without effecting a cure. At last the physicians agreed that the merchant must die; some said on the fifth day, others on the seventh day. Now Jīvaka, the physician in ordinary to the King of Magadha, was sent for, and he promised to cure the merchant if he would give him a good fee. "All that I possess shall be yours, doctor, and I will be your slave," said the merchant. "Well, my good householder, will you be able to lie down on one side for seven months?" asked the doctor. The merchant said he would. Would he be able to lie down on the other side for seven months, and on his back for another seven months? The patient thought he would be able to do so. Upon this the doctor ordered him to lie down, tied him fast to his bed, cut through the skin of the head, drew apart the flesh on each side of the incision, pulled two worms out of the wound, and, showing them to the people, said: "See, sirs, these two worms, a small one and a big one. The doctors who said that the patient would die on the fifth day had seen the big worm, those who said he would die on the seventh day had seen the small worm." Then he stitched up the skin of the head, and anointed it with salve. But after seven days the merchant said he could not lie down any longer on one side. Jīvaka ordered him to lie down on the other side for seven months. Again, after seven days, the patient said he could not bear it any longer. The doctor ordered him to lie down on his back for seven months, but he could bear this for seven days only. Then the doctor told him that he was quite well now, and that he knew beforehand the patient would be well in three times seven* days, but if he had told him so at the outset he would never have lain down even for so short a time.

This Jīvaka was a respectable man, an esteemed friend of Buddha himself, and a pious Buddhist. That the science of medicine had reached a comparatively high stage of development at the period when the Buddhist scriptures were compiled (say about 350 B.C.) is proved by the chapter on medicaments found in the "Vinayapitaka,"† and by the various stories told of Jīvaka. Yet there are traces even in these stories showing that physicians were considered as a class of uncanny creatures. "The physicians are cunning people," says King Pajjota, one of Jīvaka's patients. In the ancient Hindu, i. e., Brāhmanic, law books, a very low social position is assigned to the physicians. They rank with temple priests (who are in attendance to some popular idol), sellers of meat, hunters, usurers, women of bad character, outcasts, thieves, and eunuchs. They are not admitted to funeral meals and sacrifices, they receive no hospitality from members of the highest castes, and no orthodox Brāhman is allowed to accept food from a physician.

This degraded position of the medical profession in ancient India is, no doubt, due to the fact that in India, as in other countries, the physician is the direct descendant of the wizard and sorcerer. And although I do not believe that Sir Alfred Lyall‡ has succeeded in proving witchcraft to be "the aboriginal and inveterate antagonist of religion or theology"—the witchcraft practices of the ancient Hindus, and of all primitive people, rather prove an intimate connection between witchcraft and popular religious belief—yet I think he would be right if he had said only "theology," instead of "religion or theology." Witchcraft is always opposed to theology, and there is a natural rivalry between the wizard and the priest. And, as in India, the Brāhmans, the professional theologians, became the most dominant class, their antagonists—the wizard and his descendant, the physician—were naturally degraded and excluded from the higher ranks of society.

This antagonism between witchcraft and theology is the same as that between science and theology in more recent times. For the witch who depends not merely on supernatural agencies, but on actual observation of natural phenomena and on some sort of reasoning (which may not be logical, but can always be justified on psychological grounds) is, after all, the humble precursor of the man of science. To quote again Sir Alfred Lyall, "he is just touching, though he may only touch and let go, a line of thought which points, albeit vaguely and most crookedly, toward something like mental independence." It is this historical connection between witchcraft and science that gives an intrinsic scientific interest to the study of folk-medicine.—M. Winternitz, in Nature.

* See W. G. Black. "Folk-Medicine," p. 32 seq.

* Compare the importance of this number in the witchcraft practices mentioned above.

† See "Sacred Books of the East," vol. xvii., p. 41 seq.

‡ "Asiatic Studies," 1884, p. 76.

TREATMENT OF BURNS AND SURFACE WOUNDS.

THE surface wounds of a lower animal, such as a dog, heal, as a rule, very much better than those of man, particularly when the former has not, and the latter has, had the advantage of experienced surgical aid. I do not know that a dog has a like advantage as regards deep wounds such as those caused by a bullet, a lance, or a sword; on the contrary, I imagine a man deeply wounded and tended by a surgeon has a better chance of speedy recovery than a dog with a similar wound that receives no skilled aid. But this is not so in the case of superficial wounds. As regards deep wounds, even if the man receives no skilled aid, and if his tissues have not been poisoned by alcohol, he yet recovers as quickly as the dog, as witness Turks and Afridis wounded on the battlefield. Apparently, therefore, the human being is not less capable of speedy recovery than the brute. Why, then, his slow convalescence from superficial wounds? I think the explanation is to be sought in the mistaken efforts of the surgeon.

When a dog receives a superficial wound—such as a burn or a scald—he merely licks, and keeps it clean; when a surgeon has charge of a man similarly hurt he places on it a variety of surgical dressings. But if a piece of the best of surgical dressings is inserted under the skin, violent inflammation ensues; usually there is suppuration, which continues till the foreign body is voided in the discharges. At the best, inflammation leads to encystment. But when the skin is destroyed, as in the case of a burn, to these very subcutaneous or subcuticular tissues, which are so intolerant of foreign bodies, it is the rule to apply foreign bodies, i. e., surgical dressings. Surely no more unscientific procedure can well be conceived! Is it not evident that in this particular the dog is superior to man in surgical science and that the effort should be to keep wounds free from foreign bodies—discharges, bacteria, surgical dressings, etc. Is it not abundantly evident that when superficial wounds heal in man, particularly civilized man, they do so, not in consequence of, but in spite of, the aid given, professional or otherwise?

In view of these considerations I venture to suggest a simple method of treating surface wounds that at least is not in general use but is merely a modification of the "open" system. Briefly, I do not place the surgical dressings on the wound but on a light wire cage or support, which thus, while affording abundant protection, are not permitted to act as foreign bodies. The wire support is easily manufactured. If the wound is on a flat surface—as on the chest—a stout wire of suitable length is bent into such a shape that when placed over the wound it surrounds the latter but rests everywhere on uninjured tissue. On this wire as basis is woven a wide network of lighter wire, so that a shallow dish of wirework shaped somewhat like the wound, but larger, results. If the wound is on a limb, a cylinder of similar wirework is made in two longitudinal parts, which are hinged together, so that the cylinder may be easily applied to, or removed from, the limb. The circumference of the shallow dish and the ends of the cylinder are padded by wrapping some soft material—carbolized wool, for instance—round the thick supporting wire. When in place the apparatus may be covered by any dressings the surgeon chooses and it is retained in place by strapping or bandages.

On one detail of the treatment it is necessary to in-

sist with the utmost emphasis—the surface of the wound must be kept absolutely clean. It should be gently sponged daily, twice, thrice, or oftener if necessary, with some mild antiseptic fluid such as boracic or weak carbolic lotion, otherwise the discharges, coagulating on the surface, form a cake under which pus is retained and which proves in experience more hurtful than any other foreign body. In order as much as possible to prevent the discharges drying and so caking, I usually cover the supporting cage with wet lint and the whole with waterproof. If, in spite of precautions, the lymph does cake, it may be softened by soaking in olive oil and then removed. The advantages claimed for the above method are:

1. It is rational, whereas the methods generally in use are pre-eminently irrational; hitherto the advance in surgical procedure has been in the direction of substituting for irritating applications others less irritating but still harmful. For example, we have substituted antiseptic for septic dressings, and one surgeon has for ordinary antiseptic applications substituted metal plates. The present method seeks to abolish altogether the use of foreign bodies as applications while retaining them for purposes of protection.

2. The apparatus is very easily made, as may be proved by any one possessed of sufficient wire and a pair of pliers; it is, moreover, easily sterilized by boiling or immersion in an antiseptic fluid.

3. The wound is very quickly, easily, and painlessly dressed. No longer has the wretched patient to endure the agony accompanying the recurrent stripping of adherent dressings from an inflamed and exquisitely sensitive surface, as, for example, a large burn.

4. The dressing requires no particular skill and therefore this method is especially suitable to the poor when suffering, for example, from varicose ulcers.

5. Wounds heal with a quickness as delightful to the surgeon as to the patient. No longer do superabundant granulations arise; deep ulcers rapidly fill up to the level of the skin; the whole surface takes on a healthy aspect in preparation for the zone of young skin which advances uninterruptedly from all sides till the process is complete; no longer do healed surfaces "break down," as is so commonly the case when dressings are applied directly to the surface; and seldom, so far as I have been able to observe, do thick cicatrices occur, the contraction of which is so frequent a cause of deformity. These thick cicatrices result from the formation of fibrous tissue due, doubtless, in severe cases partly to considerable tissue destruction, but more generally to the mere irritation induced by the presence of foreign bodies. They do not occur in deep wounds when there is no great tissue destruction and from which collections of pus and other foreign bodies are from the first absent; and they rarely, if ever, follow the surface wounds of animals, which I have seen of huge size abroad (e. g., the saddle galls of horses). I take it, in fact, that the formation under dressings of a thick layer of fibrous tissue, or of tissue which subsequently becomes fibrous, is a process of the same order as that by which a foreign substance within the body becomes encysted and is thus separated by a tissue more resistant from others less resistant.

6. The method is almost ideally aseptic. It must be remembered that the bacteria of putrefaction have their habitat not in healthy tissues but in dead organic matter. The living tissues are germicidal. The present method aims at the quick and effectual removal of the nidus; under methods ordinarily pursued the discharges are banked up on the wounds for varying periods and are made antiseptic by poisons which, since they are inimical to the life of the bacteria, must generally be inimical to the life of the tissues.

Lastly, the whole treatment is very much less disagreeable than ordinary methods to the patient. The sufferer no longer feels a gradually increasing sensation of heat, pain, and discomfort as the discharges accumulate beneath the sopping dressings, nor does he behold the nauseating mess usually found when the dressings are removed. In the absence of irritation little pus is formed and the exudation is mainly serous.

I have made high claims for this "cage" method of treating surface wounds. But I shall be only too glad if surgeons will submit it to the severest tests possible. Let them, for instance, treat thus old and foul varicose ulcers which have defied all other methods of treatment or wounds which have repeatedly broken down. Or let them cover the whole of a wound with such an apparatus as I have described, but under the cage on part of the wounded surface let ordinary surgical dressings be placed. Then let the difference of behavior between that portion of the wound which is in contact with an irritating foreign body, i. e., the surgical dressing, and that portion which is not so affected be observed. Even when small the portion covered by dressings will be the last to heal. Or let vaccination vesicles, which are ordinarily treated in accordance with rational principles without dressings, be covered with "protective," the commonest of surgical dressings. The surgeon will receive an instructive object lesson as I did on an occasion when I unwittingly performed an unhappy experiment. I vaccinated a man who was about to enter one of the public services. He subsequently complained that the vesicles interfered with his work, and, thoughtlessly, I covered them with protective, whereupon the surrounding area underwent severe inflammation.

If the above experiments be tried, I think surgeons will come to the conclusion that surgical dressings when applied to wounded surfaces are anachronisms, relics of barbarous times when even more pernicious dirt—i. e., matter in the wrong place—was applied to such surfaces. We now strive to remove foreign bodies from deep wounds; we should strive to remove them from surface wounds also.—Archibald Reid, in The Lancet (London).

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